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PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR



VOLUME 7 – NUMBER 1

FALL 1986



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Cover: NPS staffers from Gateway NRA and the NPS Cooperative Research Unit at Rutgers University take samples at the interface of the Fountain Avenue landfill and Jamaica Bay.

Growth and change, dictated by pressures from within and demands from outside, are hallmarks of any living thing. *Park Science*, in this issue, (p. 5) looks at a snapshot of its growing, changing self, as presented in the results of a 1985 readership survey, and contemplates how and to what purposes it is evolving.

Since the first issue, as *Pacific Park Science* (Pacific Northwest, Western and Alaska Regions only) in 1980, to the present, *Park Science* has added new sections with "standing heads" (such as MAB Notes, Computer Corner, Research Notes, Meetings of Interest, etc.), almost always in response to reader interest and demand.

In this issue, we come up with another – Revegetation Notes (p. 4) – the result of a meeting of scientists and resource managers in that field who met informally at the July NPS-George Wright Society science conference in Fort Collins and then formally requested such a heading.

It is the hope of the editorial board that readers will look for – and find – themselves in this survey. If the story properly reflects your views, then you're in line with the majority of respondents. If you weren't contacted and you have something different to say – a suggestion for additions (or subtractions) in *Park Science* content, your letters will be welcomed and given thoughtful consideration. Feedback from interpreters will be particularly interesting, especially in view of Director Mott's desire that interpretation emphasize scientific research and management of the National Park System.

APPROXIMATE DEADLINES FOR RECEIPT OF MANUSCRIPTS

Winter issue: November 1

Spring issue: February 1

Summer issue: May 1

Fall issue: August 1

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NPS Plays Key Role in Determining Future of Gateway's Jamaica Bay

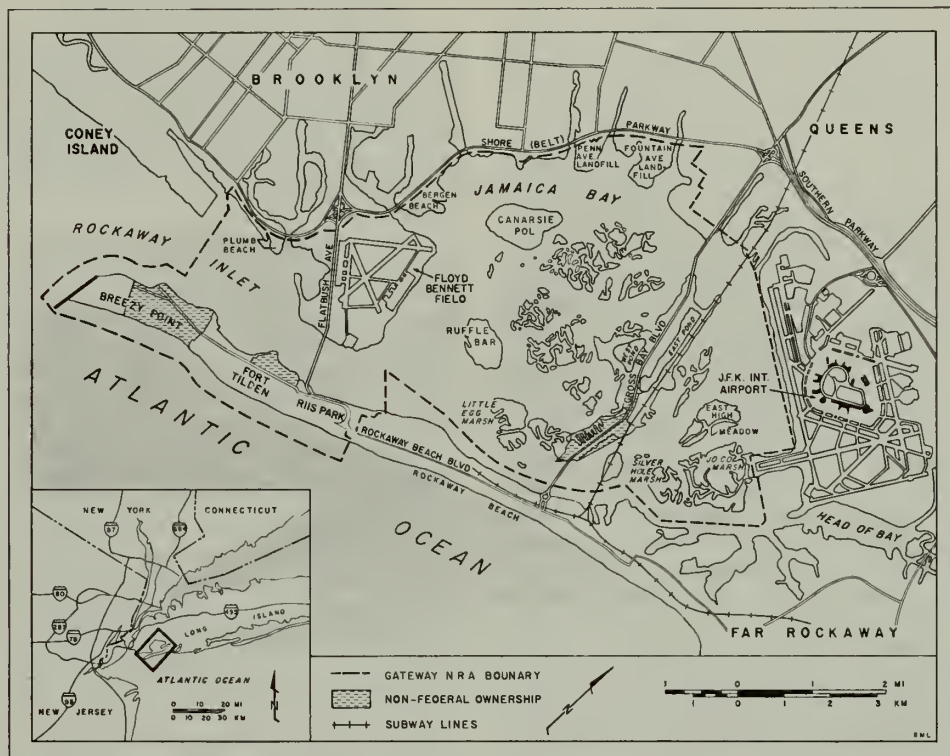
Editor's Note: The following article is the text of a talk given to students at the Harvard School of Design by Michael A. Soukup, Chief Scientist of the North Atlantic NPS Region.

The National Park Service has a major interest in the future of Jamaica Bay, Gateway National Recreation Area – an important ecosystem with a long and fascinating history. The Bay is a large, diverse, teeming estuary nearly in the shadow of the Manhattan skyline, and is seen daily by millions of people. Here, the Service's role is not one of preserving an untouched resource, but rather that of shepherding the recovery of one now extremely stressed.

In earlier times Jamaica Bay was a center of Indian habitation. Elk, bear, deer, raccoon, plus an abundance of fish and shellfish provided a varied diet along its shores. With the arrival of Europeans, agriculture and salt-haying became prevalent, with exploitation of fisheries becoming more important after 1865. Towards the turn of the 19th century, the area had become a fisheries giant – touted to be the best in the nation because its shallow (mean depth: 4m) teeming waters were uncommonly suited for rapid shellfish reproduction and growth. At the same time it became more and more of a resort area for those seeking refuge from the rigors of New York City life. Seasonal cottages then were followed by year-round homes. By 1917, an estimated 50 million gallons per day of sewage were being discharged into the Bay. Not surprisingly, outbreaks of typhoid and gastroenteritis appeared.

In retrospect, these outbreaks probably contributed to a dramatic shift in the perception of the Bay, from an attractive and bountiful haven to that of a sullied and potentially dangerous area to be avoided. The appearance of fertilizer factories, which processed New York City's horse carcasses, and fish processing factories were clear signals of (and confounding contributors to) the Bay's lowered esteem. There followed periods of real estate speculation and attempts to transform the Bay into an international port – for which it is an especially ill-suited natural feature. After massive dredging and filling, these attempts failed.

In 1930, Robert Moses saw a new future for the Bay: a park for urbanites isolated from natural areas. Moses was a visionary but also a pragmatist, yet his creation of a wildlife refuge and a Shore Parkway



Site map, showing the Fountain Avenue and Pennsylvania Avenue landfills and their positions relative to Jamaica Bay.

constituted only partial success. With the establishment of Gateway National Recreation Area in 1972, the Service inherited not only these two creations (including the Service's only wildlife refuge), but also a pivotal role in the future perception, treatment and viability of the Jamaica Bay ecosystem.

Exactly what do we have and what will we do with it? Jamaica Bay today covers an area of 52 km² – (of an original 101 km² the rest was filled). Roughly 31 million cubic meters of rain fall directly on the Bay, while the remaining input of surface water is either treated sewage (60%; or 320 million gallons per day) or urban runoff (40%). Tidal exchange is limited to a narrow inlet, 1 km wide and 7 m deep. The extension of John F. Kennedy International Airport runways into the Bay reduced tidal circulation such that the flushing time has been increased from 10 to 35 days.

Clearly, it is an understatement to say that there are formidable stresses on the Jamaica Bay system. Nevertheless the Bay has endured surprisingly well.

This survival is apparent in a recent benthic survey carried out under contract with Brooklyn College (Franz and Harris 1985). These investigators found – much to their budgetary dismay – a far greater faunal diversity than expected. With all impacts accruing to the Bay, the invertebrates, the fish community, and even the diamond-back terrapin still survive in good numbers. As expected, the body burdens of heavy metals within these animals reflect their surroundings and indicate various sources of pollution. Nevertheless it is amazing and encouraging that a system surrounded by one of the largest urbanized areas in the world shows such resiliency.

Continued on page 4



Manhattan's skyline, including the twin towers of the World Trade Center, presents a sharply quizzical contrast to the Fountain Avenue landfill adjacent to Jamaica Bay – three separate expressions of "what man hath wrought."

NPS Plays Key Role

Continued

Recent symposia organized by John Tanacredi (GATE Resource Manager) have drawn many specialists, who have concluded that conditions in the Bay are indeed improving significantly. Tanacredi also has initiated fishing and shellfishing surveys, as well as research on PCB contamination in fish and shellfish, because recreational use of these resources remains important to local citizens.

Perhaps the most challenging long-term threat to our bay system are impacts from two large landfills acquired by NPS from New York City. The last deeded right for use of the Fountain Avenue Landfill (at 6000-8000 tons per day) expired in December, 1985. The City fought hard to retain its operation on the Fountain Avenue Landfill, but the Service closed both landfills for good, citing "bird strikes" at JFK Airport, environmental impacts on the Bay, and operational violations by NYC as overriding concerns. JFK Airport had led the world in number of bird strikes. Thirty percent of its flights were 750 feet above the landfills, where gulls, "towering" on thermals, abound. P.A. Buckley (at the NPS Rutgers Cooperative Research Unit) has worked with the FAA and with JFK airport officials on reducing those strikes and, with the closure of Fountain Avenue, is now working on the Laughing Gull components of bird strikes there.

A major concern now is that the leachate associated with these old landfills (and any landfill in the temperate zone) may also contain toxic wastes. Recent testimony before Congress by illegal ("mid-night") toxic waste haulers indicates that millions of gallons of such wastes were illegally dumped at these two landfill sites. PCBs are now leaking from the smaller Pennsylvania Avenue site. As the City of New York closes these sites, it is vital that the Service insures that every means of isolating their influence upon Jamaica Bay waters be considered.



John Tanacredi, Resource Manager at Gateway NRA, takes samples at Fountain Avenue landfill for priority pollutant analysis.

revegetation notes

A "revegetation working group" composed of several park and natural resource managers and park and university researchers emerged informally and spontaneously at the July NPS-George Wright Society science conference in Fort Collins, Colo. Their objective is to form a nucleus that will increase communication among park staff members working in revegetation.

The issues that brought the group together include concern over the lack of field consensus on how best to relate work in these areas to management objectives, the need for a more formal network than currently exists among field personnel with experience in these areas, and the difficulties that various participants experience while trying to locate appropriate sources of plant materials for use in revegetation. Other common concerns include the specifications for revegetation work in contracts and the selection of appropriate revegetation techniques.

Participants agreed that the working group's first step should be to form a "revegetation network" by circulating to interested field staff members a list of field personnel involved in revegetation, vegetation rehabilitation, and vegetation restoration work,

together with the personnel's specific areas of expertise.

Anyone involved in park revegetation work and interested in receiving such a list may write to Mary Hektner, Resources Management Division, Redwood National Park, 1111 Second Street, Crescent City, CA 95531. Please include the following information: (1) Your name, mailing address, and phone number; (2) a list of the vegetation types you are working with; (3) a list of the revegetation techniques you have used; (4) a description of the types of revegetation information you currently are most in need of; and (5) a description of what information on techniques of how-to-develop-reveg programs you feel the Service should publish for Servicewide distribution as part of the Natural Resources Report Series.

Hektner must receive your information by Dec. 1, 1986, if you are to appear on the list.

Karen Simpson, Program Analyst
NPS Washington Office

At Olympic NP, preliminary work is underway on the Soleduck Road revegetation project, with Nancy Dunkle, DSC environmental specialist, in charge. At this stage, the work consists primarily of identifying native plants along the old roadway and establishing them in a nursery so that they can be used in replanting roadsides after work on the roadway is completed in 1987. A story on the project, by Candy Moger, management assistant in the Pacific Northwest Region, is slated for the November issue of *The Courier*.

For those interested in vegetation management elsewhere in the world, the most recent issue of *Australian Ranger Bulletin* (Vol. 3, No. 4, 1986) is devoted to this broad topic. Control of several weed species such as mimosa, bitou bush, and prickly pear is highlighted, including techniques such as the Bradley method of bush regeneration, planting out, and direct seeding. An example of vegetation management for wildlife conservation is provided by the work being carried out in the Tanami Desert.

Approaches to vegetation management covered in the issue include weed control, revegetation of degraded areas, and the use of fire to produce a plant mosaic. Also called for is longer term vegetation monitoring to see if current conservation practices are achieving their objectives.

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Ahlert, R.C., M.M. Chapiga, J.D. Enzminger, W. Goldfarb, D.S. Kosson, H.L. Motto, A. Rauch, C.M. Witmer, 1985. *Evaluation of Landfill Closure Requirements, National Park Service Report, North Atlantic Region*. 70 pg.

CORRECTION: The second of two parts of the article by Dr. Rosemary Nichols, based on "A Needs Assessment-Based Review of the NPS Science Program in the Rocky Mountain Region" by Nichols and Katherine Kitchell, promised for this issue, will appear instead in the Winter issue of *Park Science*. Part One, in the Summer issue, dealt with subject from the superintendents' point of view. Part two will present the subject as seen by RM Region NPS scientists.

Park Science Readership Survey

By Kristen Martinson and Donald R. Field
NPS/CPSU, Oregon State University

The communication of scientific information to scientists, park managers, and special interests groups is vital to the continuance of science and to the sound management of natural and cultural resources. The communication process is critical to the translation of science into usable knowledge for the practitioner. *Park Science* is designed to be one forum for the dissemination of scientific information to professionals in the natural resource management field.

A survey on the readership of *Park Science* was conducted as a guide for the editorial board in evaluating whether the bulletin is meeting the intended goal. The primary objectives were to identify who reads *Park Science* and to assess the readers' evaluation of the bulletin.

Park Science is distributed in two ways; first to individual subscribers and second in bulk through region offices to individual National Park Service areas. The study was therefore conducted in 2 phases. In Phase one, general socio-demographic information was collected from individual subscribers to identify who reads the bulletin and then to solicit their evaluation on the content of *Park Science*. The goal in Phase two was to see how *Park Science* is viewed by specific park work units, and how use and evaluations of *Park Science* differ by the type of job and kind of NPS area where the job was located.

Information was collected through a questionnaire sent to participants in winter and spring of 1985. Eighty-two percent of the questionnaires were returned completed from the Phase one respondents and 70 percent (from 92 percent of the parks surveyed) were returned from Phase two respondents.

Characteristics of Subscribers

In summary, the majority of respondents from Phase one of the study are middle-aged males, employed by the NPS or other resource management agency, and have completed some graduate work in college. Specifically, the average age of the participants is 42 years with the greatest number of readers being 33 years old. Approximately six out of every seven respondents are male. The majority of readers have received higher educations, attending an average of 19 years of school. The most common areas of study during college or technical school were biology, forestry, and resource recreation management (including majors in park administration). Zoology, wildlife and botany were the next most common majors reported.

Most of the readers who responded reside in the western half of the United States, primarily in the Pacific Northwest and Western Regions of the National Park Service.

As expected, most participants are directly or indirectly involved with resource management as an occupation. The majority work with a natural resource oriented agency or a college of natural resources, or they write about natural resource issues. Individual subscribers comprise about one-third of the distribution and federal government employees constitute over half of these. Of these federal employees, 81 percent are with the NPS, primarily as natural scientists, managers, resource management specialists, and rangers. NPS employees have worked for the Service an average of 12 years, their experience

ranging from six months to over 30 years.

For those readers not employed by the federal government, the greatest percent are affiliated with a university as faculty, staff, or students. The next largest employer is state governments, primarily parks and recreation and fish and game departments.

Behavior and Evaluations

The overall behavior, or method, of reading of *Park Science* appears to be fairly attentive and comprehensive, particularly considering the extensive amount of literature passing through the readers' hands on a daily basis. Respondents generally have read or glanced through the last four issues beginning with the first feature article and continuing through the entire bulletin. They tend to save the entire issue or portions of it for future reference.

Content area evaluations show consistent findings in Phase I of the survey. The content areas with the widest appeal are the Feature Articles, followed by the Research Notes, Regional Highlights, and Information Crossfile. The sections which appear to appeal to a more select group of respondents are the Superintendents' Corner, Letters to the Editor, and Editorial. None of these last 3 sections was read very thoroughly, or found particularly interesting or influential to a great number of readers.

Variations by Park Type and Positions

For Phase two of the survey, three park types were identified; natural, recreational, and historic. The four general types of NPS positions identified were maintenance, resource management, visitor services/law enforcement, and interpretation.

Some interesting differences were noted by orientation of the park. Historic parks had the largest percent of interpreters who responded, perhaps because these are areas where the public often demands the most detailed interpretation of relatively recent events. Historic parks also had the fewest respondents in maintenance.

Overall, respondents from recreation oriented parks tend to be associated with resource management and the most comprehensive readers while those from historic parks seem to be the least comprehensive readers. From additional comments on the survey it has been assessed that many readers of *Park Science* from historic parks feel that much of the information covered is not readily applicable to them. The greatest percent of respondents who find the bulletin *not* useful are from historic parks.

Respondents from natural parks are also more often than not associated with resource management and particularly interested in Research Notes and Regional Highlights. This may be influenced by the fact that much of the biological and social research occurs in natural area parks. These respondents may enjoy reading about research they've been involved in or know of in *their* region.

Differences in some responses were also noted by the reader's position in the National Park Service. Responses from interpreters and law enforcement personnel do not differ significantly from the responses of all participants together. However,

maintenance and resource management personnel have fairly divergent response as well as different demographic characteristics. Readers in maintenance have, in general, been with the NPS longer, are older, and are less likely to have had any graduate work in natural or social science than those readers in resource management. This may result in maintenance personnel not being as integrated into scientific research and resource management issues as personnel who have more recently left academia and who are directly involved in arranging or conducting research in parks. As several comments indicated, some maintenance respondents feel that the bulletin is inadequately circulated to their division. Whether interested in *Park Science* or not they may not have as many opportunities to review the bulletin.

Overall, responses revealed that of the four divisions identified, readers in maintenance appear the least interested and influenced by *Park Science* while readers from resource management appear to be the most interested and influenced. Maintenance personnel are much more likely to circulate the bulletin, rather than save it. Perhaps this is an indication that these respondents would like the bulletin distributed better, or, on the other hand, that they have little use for *Park Science* after reviewing it once.

Comments

Many participants provided additional comments. Some requested more information and details to be provided in Research Notes and articles covering research projects. Some readers requested additional sections covering items such as employment opportunities and information on current meetings and symposiums, as well as articles on a wider variety of topics like visitor services, carrying capacities, archeology, and geology. Other topics of interest mentioned by respondents were information on laws and policies which affect the National Park Service, more articles on specific case studies describing problems and solutions, short technical "how-to" notes, annual reports on current research in the parks, and notes on computers and software applicable to NPS tasks.

Many respondents reported they enjoy the bulletin but rarely spend much time reading it while those whose employment is most directly linked with the content of *Park Science* indicated they wait anxiously to receive and read each new issue. Several participants suggested changes to improve the format and layout of *Park Science*. Some readers feel the bulletin hasn't found a proper place in the resource management literature, and yet it is beginning to "fill an important niche between the technical journals . . . and the popular magazines . . ."

Overall, *Park Science* appears useful to most respondents, primarily to keep them informed on current events in resource management. Though some readers would like to see changes in the bulletin, the majority of comments supported the publication and indicated that *Park Science* is a useful information source; "an information junkies' delight . . ."



Scientists Hear Mott Call For 'Long View'

More than 350 conferees at the opening session of the fourth triennial conference on Research in the National Parks and Equivalent Reserves (July 13-18, 1986, Fort Collins, Colo.), heard NPS Director William Penn Mott, Jr., endorse the holding of future such conferences on a biennial basis.

Defining science in the parks as "systematic knowledge applied to practical situations," Mott vastly expanded the context of the phrase "practical situations" by calling for "the long-term view - 500 to 1000 years, not 3 to 5."

Maintaining that the National Park Service's overriding mission is to deliver the National Park System "unimpaired to future generations," the Director called science "an essential ingredient of park management." He told the assembled scientists, resource managers, and superintendents:

"We must be standard bearers of systematic, practical scientific knowledge as a basis for sound judgment decisions." Citing the re-evaluation of fire management at Sequoia/King's Canyon NPs, Mott noted: "We now have a far greater body of information, and if it implies the need for a change in our fire management practices, then we should be just as proud of that acquired knowledge that dictates a change as we would be if it affirmed our earlier decisions. We need to rework our vocabularies so that we view even our failures as valuable. Only the efforts from which we get NO information will be regarded as failures."

Resource inventories were called "the never ending task that can and must be tackled as on-going work - work that will provide a basis for scientists of tomorrow to use as standards of comparison."

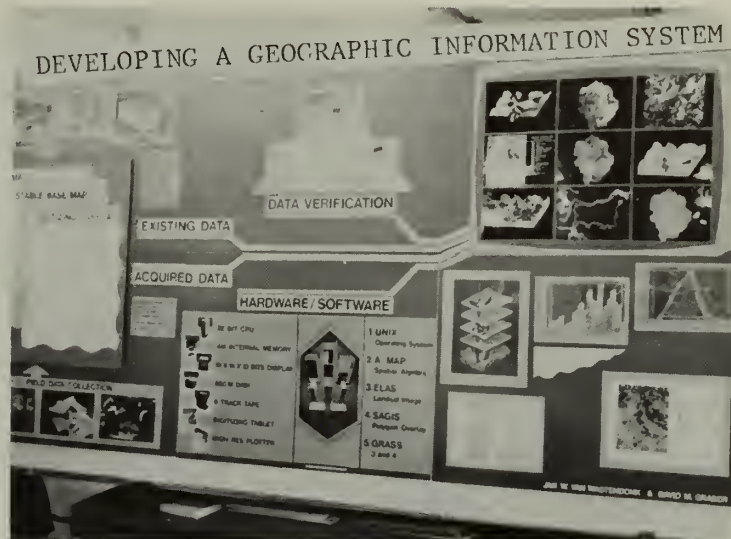
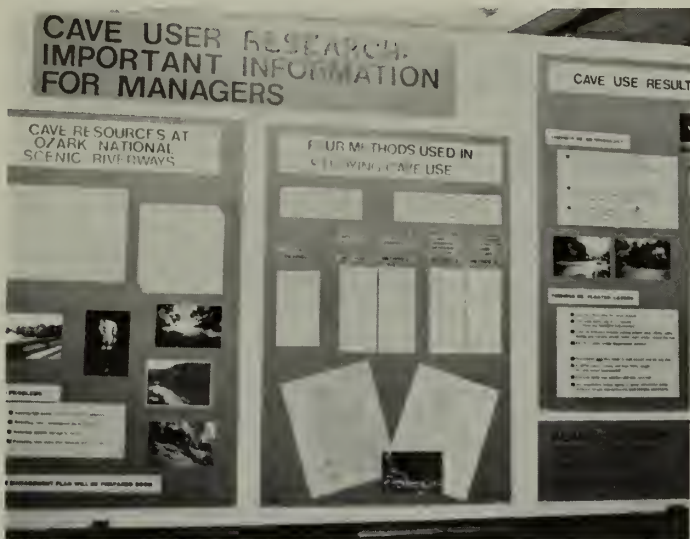
Mott coupled his remarks about the need for long-term research with strong support for interpretation. "We have told our interpreters," he said, "not to be afraid to discuss controversial management problems with the public. The public needs to understand the pressures on parks - their natural and cultural resources. It's difficult to convince Congress and the public of the need for funding us in long-term research unless they understand that need. Scientists MUST communicate with interpreters, and interpreters MUST communicate with the public."

Mott announced that a blue ribbon panel presently is re-evaluating the Leopold Report "on the basis of our new knowledge acquired since 1963," and added that the National Parks and Conservation Association's new carrying capacity formula is being tested.



Interaction was the hallmark of the conference. Above, conferees throng the poster hall to decide on the next symposium or to "see what they missed." Informal conversation was encouraged (center) by the conference facility layout. Comfortable furniture groupings in the conference hallways lent themselves to tete a tete like this one between Ro Wauer (left) and Jon Jarvis.

The new carrying capacity formula, product of a cooperative effort between NPS and NPCA, is now out in draft form for review. Preliminary field tests have been carried out this summer, and full-scale application will begin this fall at Glacier NP's North Fork portion.



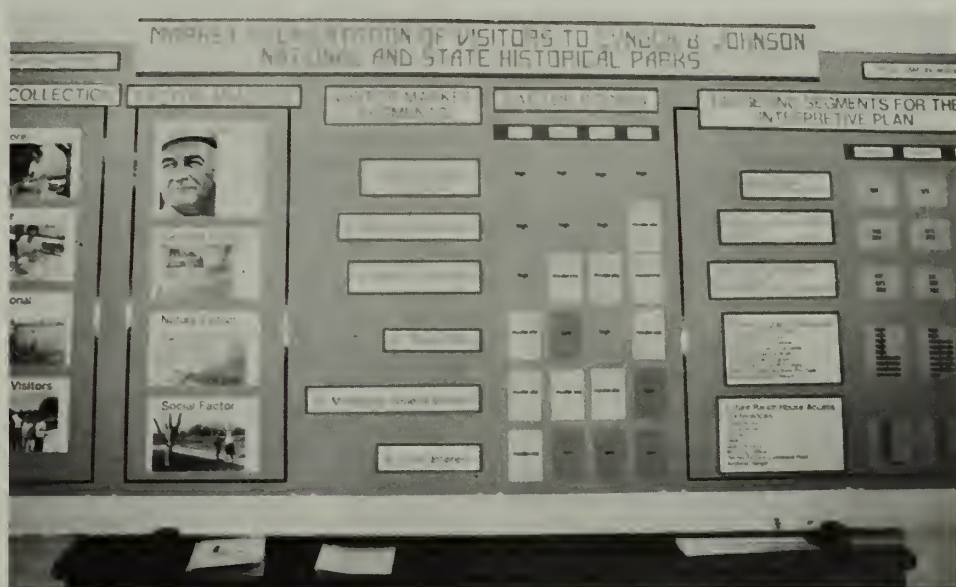
Symposia were organized around posters, which otherwise were on continuous display in the poster hall. Representative samples are shown above and below.

An article on that formula and the tests will appear in future *Park Science* bulletins.

"Above all," Mott concluded, "we are a public service agency. We must have a science program so well grounded, so well thought out, that we can explain it to the Congress, to the public, and to OMB. Ours is an element of a real world education. We believe in the validity of our science programs. We must strengthen science, interpretation, and the management of our natural and cultural resources. I pledge support for all three."

In addition to about 150 NPS personnel, conferees were from other federal agencies, state and private organizations and universities, plus representation from several other nations.

Publication of symposia presentations will be grouped into subject areas, making seven or eight different books. Conference Chairman Roy Herrmann indicated that they should be available by spring 1987.

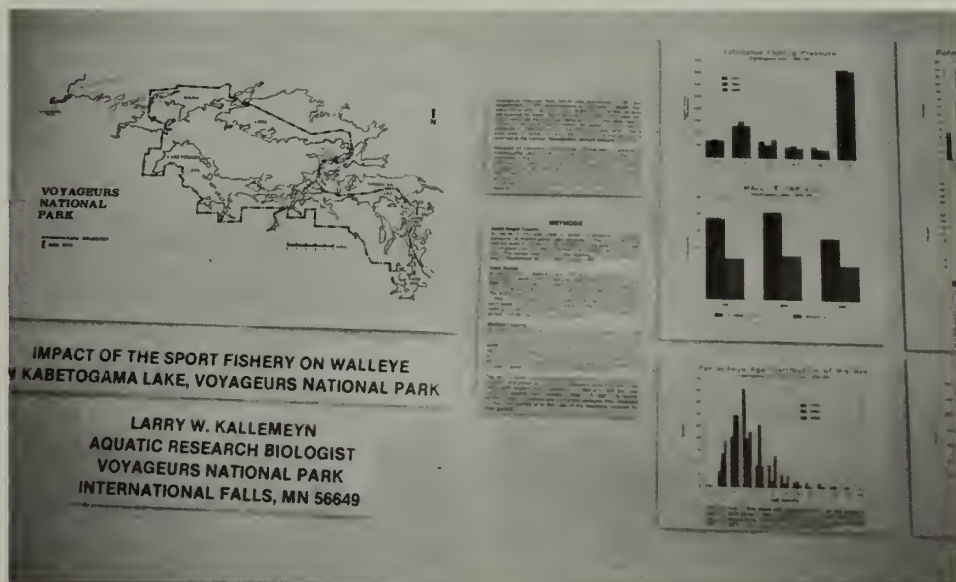


Editor's Note: Following are excerpts from a plenary session address by Boyd Evison, Director of the NPS Alaska Region, at the NPS science conference in Fort Collins.

"As managers, few if any of us need apologize for the warping of our research and resource management priorities. We have depended on the guidance of programs, policies, and guidelines generated by an organization that was managed too often by resort to quickie task forces, work groups, or committees which did their best but which did it under impossible conditions, and whose recommendations were not always applied as intended.

"Well it's time that we, as line managers of the National Park System – the Director, the Deputy Director, Regional Directors, Superintendents – get hold of this business . . . and do it with the most expert help we can get . . .

"I have been talking for a dozen years or so about the need for NPS managers to encourage baseline data collection, long-term monitoring, and effective resource management – encouraging it with great help from NPS field scientists, by an array of enticements to researchers, and creative use of limited funds and facilities to attract investment by the academic community, other federal and state agencies, and the private sector. Hand in hand with this



has been the effort to increase the awareness of those with their hands on the purse strings.

"Within the past year, we are finally beginning to

here those things put into the 'official word.' There is no question that Bill Mott's leadership has forced a turn of the corner in this."

Science Posters Worthy of 'Life After Conference'

More than 320 posters, illustrating the various symposia, were on display in Poster Hall throughout the science conference – giving rise to a suggestion by Ed Menning, Pacific Northwest Regional resource management specialist, that the posters continue to be used as learning tools.

"Many of those posters were worthy of display in the Visitor Centers," Menning observed. "They described some management problems that seldom come up in interpreters' talks, but probably should be recognized and understood by the public. Others described projects that would be of interest to visitors and that otherwise might be overlooked."

At Menning's suggestion, the poster describing San Juan Island's reforestation project is now gracing the visitor center at that National Historic Park in the state of Washington. The poster, prepared by Jim Milestone, Resource Management Trainee at PNR headquarters in Seattle, shows the reconstruction at San Juan Island of the historic scene.

Even the more technical posters – those beyond the understanding of the average visitor – could be used as ways of acquainting interpretive staff members with facts that could enrich the parks' interpretive programs, Menning noted.

Every paper listed in the 274-page Abstracts book was slated to have an accompanying poster. Only about 20 of the 350 failed to show, according to Ray Herrmann, Science Conference chairman.

Water Quality in Small Parks: A Problem-Solving Approach

By George Oviatt, Gary Larson and Larry Blake

Resource issues and their subsequent impacts on natural resources are of obvious concern to managers of park units. Finding sufficient funding and manpower to assess park needs adequately is a constant problem, especially in small units. This situation has led to some innovative strategies to meet management objectives. The strategy used at George Washington Carver National Monument (NM) to solve a series of water quality issues is an example.

The staff at Carver NM has been recognized for utilizing volunteers and student interns to accomplish many programs beyond the budget and manpower capabilities of such a small park. In 1982 a program was implemented to acquire baseline data for park's historic springs, streams and a pond. The program objectives were threefold: (1) collect baseline data using highly motivated college undergraduates supervised by park staff; (2) examine the data to uncover areas of potential impact that could require a more professional level of investigation; and (3) utilize the data as a baseline for comparison against future threats to the resource. Initial results of intern projects found coliform levels in some streams ranging upward to 50,000 organisms per 100 ml and levels of mercury in excess of 10 times the state standard. These and the results of other projects are published in a series of research bulletins available from the park upon request.

Through an established network involving professionals from EPA, the Missouri Department of Natural Resources (MDNR), universities and Regional science staff, the park staff designed a professional level program. Presented with a well organized collection of baseline data in a scientific format, the superintendent agreed that further investigation of these two issues, coliform and mercury, was critical to the protection of the aquatic ecosystem and visitor safety. The outcome, a program that utilized VIP's and networking as initial steps, was two professional contracts – one to monitor water quality and another to investigate the recharge areas for springs within the park, utilizing funding provided by the Midwest Regional Science Office.

Based on the first year of water quality data,



A VIP at George Washington Carver National Monument takes water samples at Carver Park.

potential sources of high coliform have been identified ranging from feedlots for cattle to the sewage

"We feel that this undertaking has demonstrated the potential for conducting professional level research with limited funding." Gentry Davis, Supt.; George Washington Carver NM

treatment facility for the nearby town of Diamond, MO. A spin-off of these findings has been a cooperative effort involving the park superintendent, the city administration of Diamond, and the MDNR to acquire state funding to assist the town in achieving the compliance for its treatment facility. This effort will relieve the park of a major impact on its aquatic resources.

The hydrologic investigation had two results. First it led to reclassification of a major stream that bisects the park. Instead a surface stream, it is now a "losing stream" (one that flows for a portion of time below ground), as defined by Missouri Clean Water Regulations. This reclassification brings with it stiffer penalties for the discharge of pollutants. Second, the investigation led to a tentative identification of the mercury as coming from a now defunct seed treatment operation within the recharge area of the park's historic springs. Cleanup efforts are being initiated for this area, which at one time was the site for treatment of over a million bushels of wheat with a mercury fungicide.

Continued monitoring promises to present a more complete picture of these and other potential impacts. State and local municipalities also will be assisted in correction of problems associated with discharge into the waters that flow into the park. The above discussion provides evidence that a workable system approach does exist for solving many resource management problems of a small park.

Certain prerequisites are required to achieve success from our approach. The park must have a superintendent who is concerned for the state of the park resources and allows staff members enough latitude to pursue individual interests directed toward those resources. The staff effort must include commitment to the goal of resource protection, utilization of an effective VIP program to assist in achieving those goals and the ability to network with professionals at the federal, state and local levels to provide technical assistance. Finally, it is necessary to have a Regional science staff that supports priorities based on potential for impact to park resources, regardless of unit size.

Oviatt is a Resource Management Specialist at Scotts Bluff National Monument, Larson is a Scientist with the NPS/CPSU at Oregon State University and Blake is the Chief Ranger at George Washington Carver National Monument.

George Wright Prexy Proposes GWS Broadened Role For FORUM

Christine Schonewald-Cox, newly elected president of the George Wright Society, told a July 17 dinner meeting of approximately 250 science conference attendees at Fort Collins, Colo., of her vision for the Society's publication, FORUM – as a journal platform for dialogue among park and preserve personnel who share common problems and experiences.

"FORUM could act as a sort of 'broker' for the thousands of men and women who work at the same problems in different settings, from National Parks to state parks, to private preserves – here and in countries around the world," she said.

The empty niche seen by Schonewald-Cox is for a publication that will encourage exchange of ideas and experiences – both successes and failures – across agency and discipline lines. "We badly need interaction among the sciences, including the social sciences," she said. "And FORUM dialogue could well spur the formation of sub-groups, using such modern technology as computers to develop their own corresponding, working groups."

Schonewald-Cox will elaborate on her GWS plans in an up-coming FORUM article.

New Compactable Storage System At Great Smokies

By Kathleen Manscill and Jim Wood

A new "Aisle-Saver" compactable storage system has been installed in the museum and collections storage room in the lower level of the Sugarlands Visitor Center at Great Smoky Mountains National Park (GRSM). This system enabled the park to recall natural history specimens which because of lack of space had been placed on long-term loan almost 20 years ago to colleges in North Carolina, Tennessee and Michigan. The return of this valuable material now makes Sugarlands a veritable treasure house for research.

An open house was held on April 22, 1986 to permit some 75 park employees and visitors to view the newly refurbished area. A press release publicized this event the preceding week and resulted in coverage by the *Sunday Star* and Channel 6 (ABC's television station in Knoxville).

Here, under tight security in a climate-controlled area, are stored the skins and skulls of birds and mammals collected in the Smokies as early as 1931 by the Komarek brothers, E.V. and Roy, who at that time were associated with the Chicago Academy of Sciences and are the first scientists known to have collected specimens in GRSM. Here, too, are collections of fish, amphibians and reptiles dating back to the Civilian Conservation Corps era, when men like D. Willis King were hired as wildlife technicians; plants collected by prominent early botanists R.H. Whittaker, Jack Sharp and Royal Shanks; and a variety of plants and animals collected by Arthur Stupka, GRSM's first park naturalist.

This room also houses the park's archival collection, which contains bound volumes of the Superintendent's monthly narrative reports dating from 1931, when Major J. Ross Eakin served as GRSM's first Superintendent, until 1967 when the report was discontinued. Here are land records from the North Carolina Park Commission and the Great Smoky Mountains Conservation Association, the two organizations instrumental in the purchase of lands for the park during the 1920s. Here, too, are records of the lumber companies that logged the area, scrap books, correspondence, memorabilia, and photographs of historic structures, people living in the park, and CCC and park development activities.

Employees and visitors also toured the Park Library, where Librarian Annette Evans had created an exhibit of a portion of Arthur Stupka's personal library, which was donated to the NPS in 1983. Final processing of this extensive and valuable gift had been completed only shortly before the open house. Mr. Stupka, who was an honored guest, expressed his pleasure with the display and with the return of the natural history specimens after so many years.

The specialized library contains books, oral history tapes and transcriptions, and pamphlets and periodicals mostly relating to GRSM. Here researchers find copies of theses and dissertations by former students from various colleges and universities who have used the park and its facilities in their research. A genealogical shelf contains material relating to individuals and families who once lived in the area that now comprises the park, and there is an extensive vertical file system.

The Interpretive Workroom houses the slide file, AV equipment, photo duplicating machinery, a newly

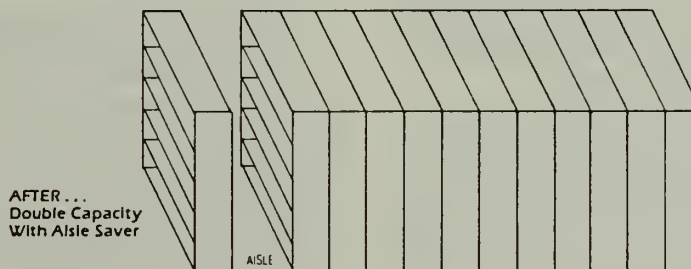
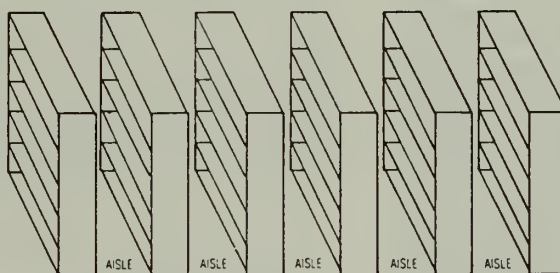


Superintendent Cook examines preserved specimens of striped skunks, part of the study collection housed in the cabinets of the new compactable storage system now in use at Great Smoky Mountains National Park.

THE CONCEPT:

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- Allows use of your existing shelves, bins, racks, cantilever shelves and cabinets

acquired Kroy lettering system, and space for interpreters to plan and view their evening programs, work on bulletin boards, and prepare themselves for the visitors' questions at the Information Desk.

The Aisle-Saver system installed at Sugarlands Visitor Center is the first of its kind in the Southeast Region. It has a load capacity of 1,000 pounds per carriage foot; its double-faced shelving is 36 inches deep and 84 inches tall, and the shelves are adjustable. The carriage on which the museum cabinets are mounted was built to specifications by the company so that standard museum cases and entomology cabinets could be mounted back-to-back. Only

one pound of effort is required to crank the handle to move 1,000 pounds of carriage, shelving, and stored items in this manually operated system (see accompanying photos and drawing).

For more information on the Aisle-Saver compactable storage system, contact Kathleen Manscill at the Sugarlands Visitor Center, Great Smoky Mountains National Park, Gatlinburg, TN 37738.

Manscill is a Museum Technician at Great Smoky Mountains NP; Wood is Writer/Editor of the NPS Servicewide Science Publications Office, Southeast Regional Office, Atlanta, Georgia.

Natural Resource Specialist Candidates Wind Up 22-Month Training Period

By Sue Consolo and Cat Hawkins

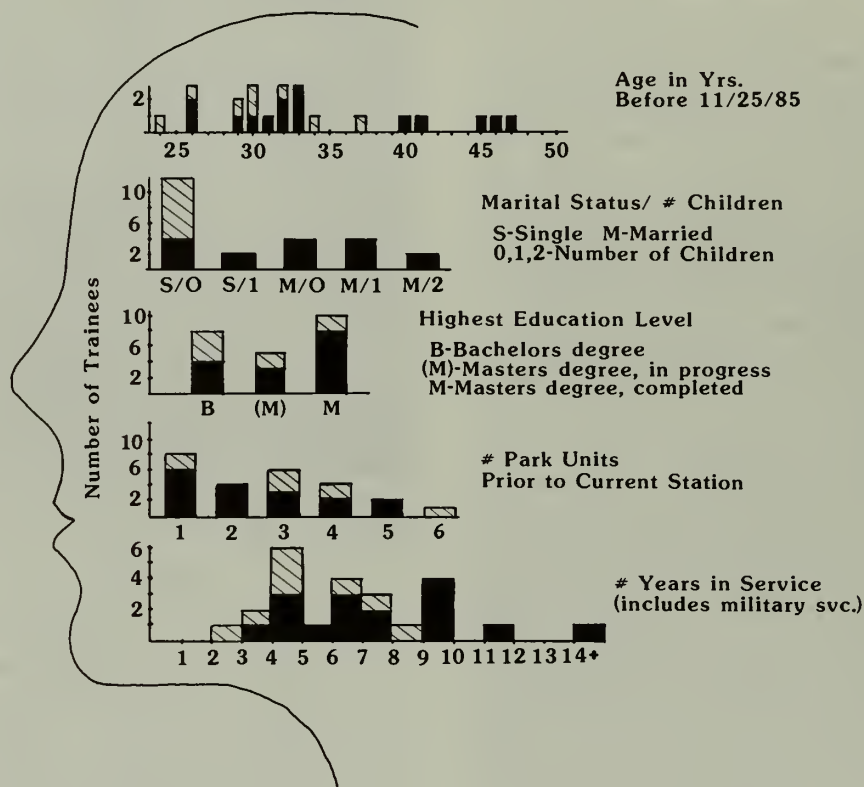
Members of the second class of Natural Resource Specialist trainees are well into the latter half of their 22-month program, having completed an intense first year of training. Since the training program began late in 1984, the 23 participants have spent 31 weeks in academic settings and the remainder of their time "home" at a training park or Regional Office assignment. All but four of the trainees relocated to new park areas early in 1985, and at the end of the program this October all will assume Resource Management positions in destination parks or Regional Offices. Training and destination parks were chosen by each Region.

The rationale for sending trainees to a training park prior to their destination assignment evolved from evaluation of the first Resource Specialist training program, which ran from 1982-84. Most participants in the first class remained in parks from which they were selected, both during and after the training period. This arrangement created conflicts between job responsibilities already assumed at their original duty stations and trainees' travel and training schedules. Coordinators of the second program reasoned that if trainees moved straight to their destination locales, new job responsibilities would conflict with the academic schedule. Thus, the concept of a training locale was developed for the 1984-86 class. Training parks were selected on 1) the presence of a natural resource program which would present a variety of issues and skills, and 2) willingness of staff to act as trainers and share their expertise. The first year was designed to present the participants with a broad range of academic studies. The second year, the trainees were to gain from practical experience and individual guidance on assignments in their regions or parks. When graduates of the current program move to their destinations, they will be well-trained and free to devote work time to their new duties.

Academic courses were selected to give all trainees a wide range of knowledge in the types of resource problems encountered servicewide. Courses were held nationwide at Cooperative Park Study Units and NPS areas, to make use of the best academic talent available and acquaint the students firsthand with a variety of resource issues. In nearly all courses, trainees were required to pass an exam or complete another graded project.

Training completed to date includes: Air Quality and Integrated Pest Management, held at the Denver Service Center; Water Resources at Colorado State University; Vegetation Management at UC Davis; Fisheries & Aquatic Systems at Oregon State University; Wildlife I & II at Texas A&M and UC Davis; Coastal Processes at Rutgers University; Mining & Minerals at the Colorado School of Mines; Geographic Information Systems at the EROS Data Center; Budget & Administration and Cave Management at Carlsbad Caverns; a series of week-long courses at Clemson University, including Microcomputer Skills, Cultural Resource Management, and Natural Resources Law; and Fire Ecology and Management, held at Boise Interagency Fire Center and Yosemite NP.

The majority of the courses were completed in 1985. This year, however, the emphasis shifted to the



PROFILE OF THE TRAINEES

Women Men

The group, composed of 8 women and 15 men, ranges in age from 24 - 47, with almost half the group being 30 - 35 years of age. Approximately half the group is single (8 women, 4 men), and half is married (11 men). All trainees have completed bachelors degrees, five (2 women, 3 men) are currently working on masters degrees, and ten (2 women, 8 men) have completed masters degrees. Disciplines in which degrees were earned cover the natural sciences (zoology, wildlife management, forestry, botany, biology, microbiology), the physical sciences (geography), the liberal arts (education, history, journalism), recreation, conservation, and land use planning. Some jobs held prior to working for the National Park Service include social worker, realty specialist, banker, teacher, forester, military intelligence officer, and wildlife biologist. The average number of park units in which trainees worked prior to their current training assignments is 2.6. Including seasonal and all other federal agency work, the number of years in service (to 12/85) for the group ranges from 2.8 to 14.5 years; the average is 6.7 years. Trainee Rich Harris (Anchorage, AK) took the picture.

in-park experience. Each trainee is required to complete a significant project to benefit his or her training park or region. Projects were chosen by each trainee and a counselor who acts as the supervisor at the training location. The trainee coordinator from WASO, Dr. William Walker, and several program consultants also reviewed the project proposals.

Training projects vary from resource monitoring, studies, and habitat evaluations to production of resource maps and planning documents. Inventories are underway of vertebrate fauna at Saint Gaudens NHS, endangered species at Indiana Dunes, the extent of oil and gas development at Big Cypress, and the ecology of the William Floyd Estate at Fire Island NS. Trainees are studying exotic plants at Rock Creek Park, collecting native seeds for planting

at Gettysburg NMP and San Juan Islands NHS, and compiling baseline data on a native spruce beetle outbreak at Katmai NP. Mount Rainier will gain an evaluation of spotted owl habitat, and Dinosaur an assessment of the historic effects of fire on plant and animal communities. Water quality monitoring programs are being developed for Isle Royale and Mount Rainier, and a river recreation study is in preparation for Ozark NSR. Trainees are producing vegetation maps for Chickasaw NRA and Carlsbad Caverns-Guadalupe Mountains NP, and an air quality monitoring program for the Northwest Alaska areas. At Hawaii Volcanoes NP, the trainee is assisting in on-going efforts to remove feral pigs. Plans are in the works for landscape management at Delaware Water Gap, and vegetation management for restoration of



The Oregon coast is the setting for this exercise in electroshocking fish. The Natural Resource Specialist trainees so engaged are (from left) Victoria Mendiola (Ozark National Scenic River), Jim Milestone (Pacific Northwest Regional Office) and Jenny Bjork (Southwest Regional Office).

vistas at Fort Foote in National Capital Parks-East. Elsewhere, trainees are writing plans to reintroduce bighorn sheep into Sequoia-Kings Canyon, and to manage exotic vegetation in Yellowstone, white-tailed deer in Shenandoah, and raccoons in the Everglades.

The natural resource training programs were initiated in response to the **State of the Parks Report**, which identified a need for better information about critical resource problems. Director Mott's 12-point plan calls for continued emphasis on strengthening resource management expertise, and the training programs have received high praise. In response to current budgetary restraints and assessment of a new approach to the program, NPS will initiate a one year class beginning in FY 1987.

As for the present class, while training and travel have sometimes been hard on families and trainees' lives at home, all the participants have enjoyed and learned much from the training experiences across the country. Beyond learning in the classroom, the trainees have built a network of friends and professionals to call upon throughout their careers.

Some of the graduates will move on to Natural Resource Specialist positions at their destination parks. Others will be classified in Ranger positions. One trainee has suggested that the class might better be called "natural resource generalists," since the thrust of the training has been to provide familiarity with an array of problems, sources of assistance, and possible solutions, rather than to create a cadre of highly specialized scientists.

More important than job titles is the graduates' willingness to join existing resource management personnel in devoting time and energy to protecting vital park resources threatened by internal and external pressures. A class member summarized the training program by saying, "I feel my perspective on management of natural resources has expanded the equivalent of several years' experience. However, more than half of learning is *doing*. I now look

forward to the challenge of applying what I've learned to problems in my destination park and future assignments."

Hawkins is a Natural Resource Specialist trainee at Mount Rainier, bound for Olympic NP. Consolo has been training at Yellowstone, and is destined for Badlands NP.

Second American Wins Travel Research Award

Kathy King Mengak, a Research Associate for the NPS Cooperative Park Study Unit at Clemson University, is the first place winner of the 1986 Wesley Ballaine Travel Research Award sponsored by the International Travel and Tourism Research Association. This is only the second time in eight years this prestigious award has gone to an American. Both American winners have been Clemson students working on National Park Service projects. Kathryn Dodd Foushee, a Parks, Recreation and Tourism major, won the award in 1982 for her work on National Parks as international tourism destinations.

The 1986 award was given for the work Ms. Mengak completed as part of a Masters degree. The project used a marketing strategy called Importance-Performance Analysis to evaluate visitors' perception of a visitor center in the Great Smoky Mountains NP. The award carries a cash stipend plus expenses to attend the TTRA Annual Conference to present the paper. This year's conference will be in Memphis.

Ms. Mengak did her undergraduate degree work in botany before earning the first Master of Science degree in Parks, Recreation and Tourism Management from Clemson. She is currently employed as an NPS Research Associate, conducting work on resource management, interpretation, and computer training projects.

research notes

The Cave Research Foundation each year offers a karst research fellowship and grants for graduate level research in cave and karst areas anywhere in the world. The research may be in the biological, social, economic, or earth sciences for the academic year up-coming. For the "truly exceptional proposal," the fellowship award can carry an annual stipend of \$3,500. In addition, it is possible for the Foundation to provide field support for work in many areas.

For more information, contact Dr. John C. Tinsley, U.S. Geological Survey, 345 Middlefield Road m/s 975, Menlo Park, CA 94025.

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Recommended reading for anyone interested in national park management is an article in the November 1985 issue of *Environmental Management*, titled "Restoring Naturalness to National Parks." In it, Thomas M. Bonnicksen of the University of Wisconsin and Edward C. Stone of UCal, Berkeley, hold that in order to manage National Parks according to the mandate to maintain them in a natural condition, resource management objectives must be defined in terms of "quantitative standards of naturalness." Such quantitative standards do not yet exist for any national park in the United States, they say. "The physical evidence needed to develop (such standards) is rapidly disappearing because of the effects of management fires, wildfires, decomposition, successional changes, and other disturbances," the authors say. Their recommendation is for "a nationwide 'rescue ecology' program to recover as much remaining ecological information as possible before it is lost."

Mammal Reference Published

A comprehensive reference to the nomenclature and distribution of mammals has been published as *Mammal Species of the World* by the Association of Systematics Collections – the organization of natural history museums worldwide, and Allen Press – leading publisher of scientific journals in the U.S. The 704-page book is available from the Museum of Natural History, University of Kansas, Lawrence, KS 66045 for \$40, prepaid.

Nationwide Recreation Survey

Results of the nationwide recreation survey conducted in 1982-83 was published in July 1986 and is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for \$4.75. The stock number is 024-005-00997-3. The NPS has a computer microdata tape of the survey for \$75 prepaid. The tape comes with complete documentation, codebook, and a copy of the NRS Methodological Report.

The study is the latest in an irregular series of interview surveys of the American public, dating back to the 1960 National Recreation Survey.

Backpackers and Backcountry Bears The Sierra Nevada Experience

By David M. Graber

Conflicts between black bears and wilderness users increased sharply beginning in the 1970s in the national parks of California's Sierra Nevada, and have continued unabated to the present time. These encounters, while rarely resulting in injury, often result in a loss of food and damage to important equipment many miles from a trailhead, and occasionally provoke visitors to shoot their ursine assailants. Some park visitors have expressed outrage at what they perceive to be a failure of the National Park Service in protecting them.

Continuing problems have generally been credited to a marked increase in the number of backpackers using the Sierra Nevada high country in the past 15 years, and a changing philosophy about bear management that has emphasized protection over manipulation of wildlife. Traditional practices that included harassment and killing bears as a means of controlling depredations seriously compromised natural ecological conditions; however, the ready availability of human food in habitats that were not previously used by black bears imposes its own measure of disturbance.

My research on black bear ecology and behavior began in 1974 in Yosemite NP and continued in Sequoia and Kings Canyon NPs from 1980 through 1984. During that same decade, the Resources Management divisions of both park units (Sequoia and Kings Canyon are administered jointly) collected substantial information about the nature and extent of conflicts between humans and bears and developed strategies to reduce those conflicts. This work has led to the evolution of "Human/Bear Management" programs with two principal objectives: (1) to restore and maintain the natural distribution, ecology, and behavior of black bears free of human influence; (2) to minimize the threat to human safety and property.

The Setting

Yosemite, Kings Canyon, and Sequoia NPs are located on the western slope of the Sierra Nevada. Elevations range from 1,500 m in the foothills to more than 4,400 m along the Sierra crest. Black bears originally occupied principally the oak and mixed conifer forests at mid-elevations. But the bulk of all 3 parks lies above 2,000 m in elevation, and the majority of backcountry use takes place in these subalpine and alpine zones.

Backcountry use increased dramatically during the 1960s and 1970s. For example, Yosemite recorded 78,000 visitor-nights in 1967 and 197,000 in 1975, declining slowly since that time. The pattern for Sequoia and Kings Canyon is similar, except that use has increased slightly in recent years. Circumstantial evidence suggests that over the same period, seasonal and permanent occupation of the "backpacking zones" by bears increased manifold.

During the study period, 1974-1984, managers experimented with control of bears, and with control of visitors and their foodstuffs as means of reducing human-bear incidents (property damage and personal injury). Bear controls included capture and relocation, aversive conditioning, and intentional destruction. Food control included visitor information, regulation of food storage and disposal, and the use

of several devices (cable, pole, locker, cannister) designed to physically prevent bear access to anthropogenic food and garbage.

Personal injury by black bears is relatively uncommon and rarely serious. From 1966 through 1976, the annual number of personal injuries for all of Yosemite NP ranged from 3 to 29 – an average of 13, or 1 injury per 292,000 visitors; only a few of these injuries took place in the backcountry. Human nature and the evidence at hand suggest that nearly all personal injuries caused by black bears are reported.

Property damage incidents are far more common, but less well documented. For all of Yosemite NP from 1966 through 1980, the number of *recorded* incidents rose steadily from 49 to 975 in 1975, then declined slowly for the next 5 years. Backcountry incident numbers for the Sierra Nevada national parks are unavailable prior to 1975, but old-timers claim they were far lower. Since then, reporting has varied in its manner of collection and hence its consistency, accuracy, and comparability. For 1976 through 1979, Jeffrey Keay and Brad Cella in Yosemite calculated that only 8-11% of actual backcountry bear incidents were reported. Thus the average annual number of *recorded* incidents for this period, 260, likely represent *between 2,000 and more than 3,000* incidents. The average number of visitor-nights during that period was 167,480, thus there were 644 visitor-nights per reported incident. During 1980 through 1984, that ratio declined somewhat to 405; the real rate probably was one incident per 40 visitor-nights or worse. From 1982-1984 in Sequoia and Kings Canyon NPs, a period of relatively consistent reporting procedures, reported backcountry incidents ranged from 251 to 258. Average visitor-nights for that period were 189,042, or 747 visitor-nights per incident. Reported values for both backcountry visitor-nights and incidents are only uncertain indices of actual numbers. This uncertainty is a serious problem, because it compromises any evaluation of management actions.

Bear Management Options and Consequences

Relocation. – Removal of problem bears to other locations has long been a favorite management tool. In Yosemite, where many relocations took place from 1974-1978, we found this practice functioned like a high mortality rate, probably contributing – through compensation – to the high reproductive rate in the remaining bears and inducing social dislocation in both contributing and recipient populations. For the period 1980-1984 in Sequoia and Kings Canyon, only one relocated bear (of 44) fitted with a transmitter successfully established a new home range away from developed areas (and abandoned it in 1985).

Destruction. – From an ecological standpoint, killing problem bears induces dislocation in only one population instead of two, and it is less expensive than relocation. Identification of problem individuals, however, generally requires one capture to mark each candidate bear, an observation period, and then location and destruction of the identified problem



Warning sign, Yosemite NP.

bear. Both relocation and destruction alter natural mortality patterns. However, since mortality rates for subadults, especially males, are already high, removal of these individuals from a population has less effect than removal of adults. In the three Sierran parks, managers have destroyed bears that injured people or seemed likely to do so in future. Neither relocation nor destruction, by themselves, correct the conditions that lead to bear incidents.

Aversive conditioning. – Attempts to condition black bears to avoid humans and their food in field conditions have been notably unsuccessful. Although food aversion might succeed in a single campground where only a few bears require conditioning and experimental conditions could be controlled, these techniques cannot be applied generally over vast wilderness areas. Resource managers in Sequoia and Kings Canyon NPs experimented on a few aggressive bears, using stones and rock-salt fired from shotguns as aversive conditioning. The treatments were difficult to apply safely and without offending visitors; the only response we could detect was that some treated bears became more wiley in their quest for campers' food. Denali NP in Alaska has experimented with rubber bullets to induce fear of humans in aggressive grizzly bears, while others have tested a variety of chemical repellents that could be applied by backpackers. These techniques are still experimental, labor intensive, and at best may be applied to a small number of individual bears.

Human Management Options

Visitor information. – Park visitors, even wilderness users, are poorly informed about the nature of black bears and the protective options available. A survey of backcountry campers in Yosemite found that although 95% had received at least a brochure about proper food control, and 92% reported their food was protected, only 3% were actually managing their food by recommended techniques. Many visitors don't know whether they are dealing with black or grizzly bears, or have a poor understanding of the differences. Although both park management units utilize extensive written and pictorial material to inform park

visitors, including special handouts to those applying for Wilderness Permits, communication of the relatively complex information has best been accomplished personally. This last option holds promise so long as funding levels can support it.

Behavior around bears. – There is increasing evidence that human timidity sometimes leads to increasing aggressiveness in both black and grizzly bears. In particular, readiness of people to give up their food to a bear without imposing some cost on the bear (such as yelling or throwing rocks) may encourage that individual to be bolder at the next encounter. As bold bears are more likely to provoke fear rather than combativeness in people, there is a positive feedback loop. After handling and observing black bears hundreds of times we never encountered a situation in which our aggressiveness provoked greater aggressiveness on the part of the bear; however there certainly are circumstances, especially at close quarters, in which visitors unfamiliar with bear behavior should opt for cautious retreat. Whereas the Sierra Nevada parks five years ago advised backcountry visitors never to contest with bears for ownership of food, rangers now are cautiously suggesting to more sophisticated backpackers that there are circumstances in which controlled aggressiveness is appropriate.

Hardware solutions. – The Sierran parks presently offer five different technological means of protecting food from bears:

1. **Counter-balance.** Tossing a food sack and line over a high limb and tying it off to the trunk or another tree to outsmart bears no longer works in the Sierra; if a bear is physically capable of reaching food or line, the food is not secure. Counterbalancing, a technique developed in Yosemite, requires the user to carry about 20 m of light, strong cord, and at least one stuff sack. Two sacks or a sack and weight are balanced over a small, live limb at least 3 m from the trunk, with the sacks at least 6 m above the ground. This technique is difficult to apply; it requires dexterity

and the proper kind of tree – unavailable at higher elevations. A small but possibly increasing number of bears are able to foil the system by breaking the limb or diving at the food sack from a branch above. (They are locally called “kamikaze bears.”)

2. **Bear-proof cable.** This technique creates an artificial limb of aircraft cable suspended between two trees. Unlike the limb, it will not break, and if a portion of it is sufficiently clear of vegetation above, it is easier to counter-balance and less subject to a bear leaping from above. Cables installed in all three parks have been popular with wilderness users. Bear-proof cables must be installed by park management, and annually maintained to correct for stretching, rusting, and accumulation of tangled cord on the cable. These artificial intrusions in wilderness tend to aggregate campers in their vicinity and may actually draw bears to a site, increasing the risk for those who fail to protect their food.

3. **Bear-proof pole.** This device – developed in Grand Teton NP – looks like a tall metal hat rack with hooks at the top; it is anchored in rock or concrete. A second free pole is used to hoist food sacks to the hooks. The device is constructed so that it cannot be bent or climbed by bears, and food is too high for bears to reach. A small number are in experimental use in Kings Canyon and Yosemite NP wilderness. Poles are an obvious intrusion in wilderness, and tend to aggregate campers. However, Glacier NP is using the poles and is deliberately grouping people in backcountry campgrounds.

4. **Food locker.** These are heavy steel boxes that cannot be opened by bears. After experimental successes at White Wolf Campground in Yosemite (1977) and Lodgepole Campground in Sequoia (1982), the three Sierran parks are installing these lockers at most frontcountry campsites and some trailheads. Eleven food lockers installed in Little Yosemite Valley backcountry campsites were accompanied by a 61% drop in incidents there between 1979 and 1980. However, food lockers are expensive to purchase and install; they must be transported by

helicopter to backcountry and are a physical intrusion in wilderness. Either a great many would be required, or present dispersed camping would have to be replaced by designated sites.

All three fixtures – cable, pole, locker – by attracting campers to specific sites raise legal questions about government liability for visitor safety where they are provided. Imposition of traditional frontcountry safety standards in these areas would significantly compromise wilderness.

5. **Food canister.** This is a portable cylinder or rectangle of plastic (e.g. PVC, ABS, or Lexan), presently 20 cm diameter and 30 cm long, 15 cm x 20 cm x 30 cm long, weighing 1.2-1.5 kg. The top fits flush with the container; the latch requires a tool to open; the overall dimensions are such that a black bear cannot get purchase with its teeth. Originally developed in Yosemite by Bruce Hastings, Barrie Gilbert, Brad Cella, and Jeff Keay, versions have been field tested by staff and visitors in the three Sierran parks, and in Denali NP. The canister can be carried inside a backpack, strapped on, or carried on packstock. The canister is just about ready to mass-produce and distribute. This method appears most promising because of its portability and minimal impact on wilderness.

The minimal data available suggest an equilibrium may have been established between visitor density and black bear use at the high elevations of the Sierra Nevada where most incidents occur. A variety of tools for reducing the number of bear incidents exist, but most of these impose penalties on wilderness values. At present, high-quality visitor information and the bear-proof portable food canister offer the best potential for lowering conflicts, minimizing other wilderness effects, and permitting a wild and natural black bear population in the Sierra Nevada.

Graber is a Research Scientist at Sequoia/Kings Canyon NPs.



Bear-proof food pole, Kings Canyon NP.



Bear-proof food canister, Sequoia NP.



Bear-proof food cable, Yosemite.

regional highlights

Alaska Region

During June, ARO wildlife biologist Layne Adams, took part in two grizzly bear studies in Northwestern Alaska that NPS and the Alaska Dept. of Fish and Game are conducting cooperatively. One study, in Noatak National Preserve and Cape Krusenstern National Monument, began this year to determine demographic characteristics of the grizzly bear population and assess effects of present sport and subsistence harvests. The other study is a long-term effort by ADF&G's Harry Reynolds to investigate aspects of population dynamics, population turnover, and potential reservoir effects of an un hunted bear population on the National Petroleum Reserve-Alaska, north of Noatak National Preserve. Between the two studies, Adams assisted in the capture and radio-collaring or ear tagging of 76 grizzly bears.

North Atlantic

Among the new studies started this fiscal year is investigation of the status of river otter at Acadia NP. Under direction of Dr. Ray B. Owens of the University of Maine at Orono, current distribution of the species within the park will be determined and suitability of aquatic habitats will be assessed.

Also at Acadia, the peregrine falcon restoration program continues for the third year, with 10 birds released in May 1986.

Development of a computerized decision aid system for fire management planning has been initiated for Acadia NP. The current plan calls for suppression of all fires. In the absence of a fuel reduction plan and with continued fire suppression activities, biomass has accumulated to potentially hazardous levels. Natural mortality in older growth spruce stands may significantly accelerate fuel accumulation in these stands. The simulation model being designed by several investigators at U/Mass-Amherst will project the long-term consequences of fire suppression on vegetation composition and forest development and aid in the resource management decision-making process.

Cape Cod NS is conducting a census of breeding pairs of the piping plover (*Charadrius melodus*) and an investigation of the possible effects of beach development, human recreation, and predation as factors affecting nest success and chick survival. The plover population has declined seriously in the last decade. In January 1986, the USFWS officially listed the species as endangered in the Great Lakes Watershed, including New York and Pennsylvania and as threatened from the Canadian Maritime Provinces down along the Atlantic Coast. The seashore is one of 12 study locations in Massachusetts being monitored by the Mass. Natural Heritage Program and U/Mass-Amherst.

Due to the rising incidence of Lyme disease among Fire Island NS park staff, the distribution and spirochete infection rate of the tick *Ixodes dammini* is being investigated. Dr. Howard Ginsberg, Rutgers University, also will prepare the Servicewide information sheet for Joseph Schock, who is the NPS Washington Office liaison person with the U.S. Public Health Service.

The North Atlantic Region is continuing to develop its Geographic Information System (GIS) capabilities for all park units. Program objectives are to expand the GI data base, to provide technical training on the capabilities and applications of this system for resource management planning, park planning, and research activities, and to provide suitable hardware and access to analytical software.

Recently the Region installed a Wang computer system. Each park in the Region now has at least one Wang PC or a workstation. With the help of the GIS Field Unit, a Textronix 4010/4014 emulation package, which will run on a Wang PC with a monochrome screen, was located. The unit has produced several digital maps on SAGIS. These, along with SAGIS, have been furnished to the University of Massachusetts-Amherst, where they will be accessible through modem communications to all park units.

Pacific Northwest

Of interest to those concerned with elk and deer population management is the decision by the U.S. Forest Service to go forward with a proposed 10-year study of interactions among elk, deer, and cattle in the Starkey Experimental Forest and Range, 30 miles southwest of La Grande, OR. The study aims at establishing animal unit equivalencies similar to the animal unit month (AUM) for cattle and to establish procedures for allocating forage for various combinations of deer, elk, and cattle. Other study objectives include determination of the effects of intensive forest management and the influence of different levels of traffic on forest roads on deer and elk. Very low male-to-female ratios and the effects of breeding by immature males on elk herd reproduction also will be investigated.

Ecology of coarse woody debris (CWD) in temperate ecosystems is the title and subject of a nearly book-length article by M.E. Harmon, Jerry Franklin, F.J. Swanson and 10 other authors in *Advances in Ecological Research*, Vol. 15, London; New York [and others], Academic Press; 1986: pp. 133-302.

Input, decomposition, amount and distribution, and roles of coarse woody debris are presented and analyzed. Conclusions compare CWD in terrestrial and aquatic ecosystems, and consider the effects of human activities on such debris. The summary suggests several recently documented areas where better scientific understanding of functions and natural factors influencing CWD dynamics should lead to more enlightened management practices.

A doctoral thesis by William D. Newmark of the University of Michigan, "Mammalian richness, colonization, and extinction in western North American national parks," and an article by Dr. Newmark in *Biological Conservation*, 33:197-208, are available on a loan basis from the Pacific Northwest Regional Library in Seattle and from Olympic NP Library,

according to Olympic Park Chief of Natural Science Studies, John H. Aho.

Mid-Atlantic

A number of Natural Resource Management and Science personnel recently attended and/or participated in the NPS Science Conference in Fort Collins, CO. Among the posters presented was one by Regional Chief Scientist John Karish titled "A Research Plan to Study Appropriate River Recreation Use" describing a major multidisciplinary research effort currently underway on three rivers in the region. Karish also participated in the Social Science and Regional Chief Scientist's panel discussions. Regional Scientist Jeff Marion served as Coordinator for a session titled "Recreation Impact Assessment and Monitoring" and presented two posters - "Recreational Impact Assessment and Monitoring: Past, Present and Future" and "The Development and Application of Campsite Impact Assessment and Monitoring Systems."

Jeff Marion reports the availability of several new publications. "Recreational Resource Impacts: Visitor Perceptions and Management Responses" by Marion and Dave Lime, discusses why visitors typically have limited perceptions of most resource impacts, why managers should nevertheless be concerned, and how impact assessment/monitoring systems and management strategies can aid reducing future impacts. "Campsite Impact Assessment Systems: Application, Evaluation, and Development" by Marion, describes and evaluates campsite impact assessment systems and outlines procedures for developing area-specific systems for use in impact monitoring. "Exotic Vegetation in Wilderness Areas" by Marion, Dave Cole and Susan Bratton, describes how exotic plants have been introduced into most wilderness environments, implications for managers, and potential methods for control. "Wilderness Campsite Impacts: Changes Over Time" by Dave Cole and Marion, evaluates long-term changes on wilderness campsites and suggests appropriate management actions for minimizing long-term campsite deterioration. Copies are available from Jeff Marion, Star Route 38, Milford, PA 18337.

Midwest Region

Douglas A. Wilcox, Research Aquatic Ecologist with the Indiana Dunes National Lakeshore, is represented in *Wetlands*, the *Canadian Journal of Botany*, and *Water Resources Bulletin*. He is the sole author of "The Effects of Deicing Salts on Water Chemistry in Pinhook Bog, Indiana," in the WRB for February 1986; and of "The Effects of Deicing Salts on Vegetation in Pinhook Bog, Indiana," in the *Canadian Journal*, Vol. 64, No. 4, 1986. In *Wetlands*, Vol. 5 (87-97) 1985, Wilcox is the author, together with Noel B. Pavlovic and Michelle L. Mueggler, of "Selected Ecological Characteristics of *Scirpus Cyperinus* and its Role as an Invader of Disturbed Wetlands."

Western Region

An 88-page report entitled "Bird Community Survey At Pinnacles National Monument," by Michael L. Avery and Charles van Riper III, has been published

as Technical Report 24 by the NPS/CPSU at University of California, Davis. Surveys of bird communities were made in seven vegetation types at Pinnacles during winter and spring from November 1983 to June 1985. Bird densities were estimated, using the variable circular plot technique, in valley oak woodland, blue oak woodland, mixed riparian woodland, California buckeye, chamise chaparral, hollyleaf cherry chaparral, and mixed chaparral. Of the 110 species recorded, 46 are year-round residents, 18 are mainly winter residents, 30 are spring residents, and 16 are transients. Sixty species are known to nest at Pinnacles and 22 others probably do so.

* * *

Charles van Riper III, leader of the NPS/CRSU at University of California, Davis, has three recent publications to report:

In the Proceedings of the Helminthological Society of Washington, Vol. 52, No. 2, July 1985, "New Species of Spiruridae (Nemata: Spirurida) from Endemic Hawaiian Honeycreepers (Passeriformes: Drepanididae), the Japanese White-eye (Nemata: Spirurida) from the Japanese White-eye Collected on the Island of Hawaii," (with Cid del Prado Vera and A.R. Maggenti); in the Proceedings of a Symposium held June 5-6, 1984 at Hawaii's Volcanoes National Park, "Hawaii's Terrestrial Ecosystems: Preservation and Management" (edited with J. Michael Scott), and a chapter from the same Proceedings, with C. John Ralph, entitled "Historical and Current Factors Affecting Hawaiian Native Birds."

* * *

"Yellow-bellied Marmots and Vehicle Damage in Mineral King, Sequoia and Kings Canyon National Park, California" is the subject of Technical Report No. 23, by Roger C. Helm and Christine Schonewald-Cox and issued by the NPS/CPSU, University of California, Davis. The report recommendations include the suggestion that the Park provide Rangers with a new report form, specifically designed to document damage by animals other than bears, plus a short form to be filled out when an animal is destroyed. "Substantially improved documentation of a problem will help both the Park and any outside person or agency diagnose a situation more accurately and rapidly," the report notes. "A terrific sodium need" on the part of marmots early in their active season is seen as driving the animals' problem behavior. Several solutions to this are suggested.

Leopold Centennial

Aldo Leopold's life and ideas – their influence upon the present and their implications for the future, are among the topics to be discussed by historian Roderick Nash, wildlife ecologists Raymond Dasmann and Dale McCullough, Arizona Governor Bruce Babbitt, former California Secretary of Resources Huey Johnson, political scientist Crain Allin, Leopold scholars Susan Flader, Baird Callicott, Curt Meine, and Sharon Kaufman, geologist Charles Bradley, and Leopold's four children – all distinguished scholars in their own right, the week of Oct. 5 through 9 at Iowa State University in Ames, Iowa.

The series of public lectures (no admission charge) will take place in Leopold's native state as a centennial celebration of the life of the influential scholar. Information on local accommodations are available from Thomas Tanner, Environmental Studies Program, 141 Bessey Hall, ISU, Ames, IA 50011.

meetings of interest

1986

Sept. 22-26, THE FIRST CONFERENCE ON PALEONTOLOGICAL RESOURCES IN THE NATIONAL PARK SYSTEM, at Vernal, UT, hosted by Dinosaur National Monument.

Oct. 5-9, THE ALDO LEOPOLD CENTENNIAL CELEBRATION, at Iowa State University, Ames, Iowa; out-of-town visitors welcome; no admission fees.

Oct. 19-24, TENTH RANGER RENDEZVOUS, at Jackson, Wyo.; contact Association of NP Rangers, Box 222, Yellowstone NP, WY 82190.

Oct. 21-24, THIRTEENTH ANNUAL NATURAL AREAS CONFERENCE and EIGHTH ANNUAL MEETING OF THE NATURAL AREAS ASSN., at Trout Lodge Conference Center, YMCA of the Ozarks near Potosi, MO. Contact Natural Areas Conference, P.O. Box 180, Jefferson City, MO 65102.

Dec. 15-16, THIRD BIENNIAL CONFERENCE ON RESEARCH IN CALIFORNIA'S NATIONAL PARKS, University of California, Davis; contact Cooperative Park Studies Unit, Division of Environmental Studies, Wickson Hall, U/Cal, Davis, CA 95616, or call (916) 752-6086.

Law Center Assesses Park Survival Chances

"External Development Affecting the National Parks: Preserving 'The Best Idea We Ever Had'" is the title of a conference held Sept. 14-16 in Aspen, Colo., sponsored by the Natural Resources Law Center of the University of Colorado School of Law. The conference focused on conflicts that arise when activities outside park boundaries adversely affect the values and purposes for which the park was established. Participants included Dick Briceland, NPS Associate Director for Natural Resources; Prof. Robin Winks of Yale University; Prof. A. Dan Tarlock of the Chicago-Kent College of Law, Illinois Institute of Technology; and a roster of authorities on the legal aspects of air and water pollution, wildlife, public and private lands, and restoration projects.

Professor Alfred Runte of the University of Washington's History Department introduced the session on historical misconceptions and ecological realities of the National Park idea with this comment:

"Historians of the national parks traditionally describe the parks as one of the highest expressions of American Culture. The merits of this interpretation aside, the issue is no longer the quality of the idea, but whether Americans are in fact committed to protection of the national parks in perpetuity. Mounting threats to the national parks, both external and internal, have finally confronted the United States with its moment of truth. National park history, regrettably, leaves little room for optimism."

A report on the conference (which was underway at press time) will be carried in the Winter issue of *Park Science*.

Indiana Dunes Research Conference

Ninety years after University of Chicago ecologist Dr. Henry Cowles began his pioneering research in the Indiana Dunes, 162 scientists, park rangers, students and dunes devotees assembled for the first Indiana Dunes Research Conference in August 1986.

Four symposia, comprising 50 papers describing Dunes research, constituted the main body of the conference. Details of the conference will be carried in the Winter issue of *Park Science*.

Coalition Hears Call For 'Bridge-Building'

About 300 people attended the 1986 annual meeting of the Greater Yellowstone Coalition May 30 - June 1 at Yellowstone Lake Lodge and heard Bruce Wilcox, Director of the Center for Conservation Biology at Stanford University, call for building bridges across the "built-in chasm between science and land managers" as essential to avoiding a catastrophic loss of biological diversity.

A central theme of the meeting was how to measure, define, and maintain the requirements of viable ecosystems – those able to support vigorous populations of a number of critical indicator species that can adapt to environmental change. Hal Salwasser, Deputy Director of Wildlife and Fisheries for the U.S. Forest Service, called for management action to counter the increasing geographical isolation of populations, a trend associated with high probability of extinction. While it is not politically or economically feasible to set aside sufficiently large areas, Salwasser said, coordinating networks of public lands represents an approach likely to succeed over the long term.

According to conference moderator Peter Brusard, Chairman of the Biology Department at Montana State University, the role of science is to show managers, as accurately as possible, the resource implications of management decisions.

Address of the Greater Yellowstone Coalition is 127 West Main, Box 1874, Bozeman, MT 59715.

30 Attend Course in Wildlife Management

Wildlife issues in the National Park System will be studied at a three-week course in wildlife management, Sept. 15 through Oct. 3, at the University of Colorado. Funded by the NPS Albright Training Center and attended by 30 NPS wildlife management specialists and biologists, the course is being coordinated by Rocky Mountain Regional Chief Scientist Dan Huff, NPS Water Resources Division Chief Tom Lucke, and Doug Morris of the Albright Training Center. A report on the course will be carried in *Park Science's* Winter issue.

information crossfile

"Foundations for a National Biological Survey"

is the title of a volume edited by Ke Chung Kim and Lloyd Knutson and published by the Association of Systematics Collections in cooperation with Holcomb Research Institute and Illinois Natural History Survey. E.O. Wilson of Harvard, in his foreword, says "The collection deserves to be read – and used – by both systematists and other scientists and policy makers for whom diversity will be an increasingly important issue in the future."

The volume deals with scientific bases for a National Biological Survey, ecological and environmental considerations, biological survey information, legislative and historical perspectives, international perspectives, and conclusions. Paul Risser, of the Illinois Natural History Survey, for example, opts for a national biological survey that would "build on the existing organizations and institutions but with enough central structure to coordinate information."

The book is \$18 and may be ordered from Assn. of Systematics Collections, %Museum of Natural History, University of Kansas, Lawrence, KS 66045.

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Tony Bonanno, assistant chief ranger responsible for managing the North Carolina unit of the Blue Ridge Parkway, is the author of an article in the Summer 1986 issue of *Ranger*, (ANPR, Box 222, Yellowstone, NP, WY 82190) titled "Multi-Specialist Rangers: A New Look at an Old Idea." Bonanno discusses the integration of traditional "protection" and "interpretation" at Blue Ridge Parkway into a single organizational unit known as RM&VS, for Resources Management and Visitor Services, begun the winter of 1983-84. He discusses the motivation, the process, the perceived values – both to employees and to the Service – and then asks a number of questions, inviting reader response to his address: P.O. Box 9098, Asheville, NC 28815.

Parkway management determined at the beginning that only through experience could they evaluate the effectiveness of the multi-specialist approach, with the real test being how well it met mission objectives. Early returns suggest that the multi-specialist approach already is surpassing in effectiveness the two-division structure that preceded it, according to Bonanno.

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The U.S. Forest Service, Pacific Northwest Region, has issued a 6-page, full color brochure entitled "Protecting the Forest . . . Fire Management in the Pacific Northwest," designed to promote public understanding of fire management in National Forests. Fire's place in the forest, the kindling for forest fires, the active use of fire, preventing wildfires, discovering fires, putting out fires, and healing the burned land are the section titles. Information is stated simply and clearly, with the clear aim of developing public support for USFS fire policies.

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"The Politics of External Threats: Visibility, Mining and the National Parks" is the title of a Ph.D. dissertation in Political Science at Colorado State University by John C. Freemuth. The 274-page document was published this summer (1986), and uses

the Tar Sands issue in Southern Utah and visibility questions under the Clean Air Act as case examples. Dr. Freemuth indicates that the natural resources policy of the administration in power, support from park policy specialists, and the role of resource oriented professionals will be vital to the resolution of the threats issue.

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For those interested in exploring issues of resource development in lands adjacent to parks, threats to parks, or Man and the Biosphere programs, the journal *IMPACT of Science on Society* offers a wide range of ideas and examples. Sponsored by UNESCO, and co-published with Taylor & Francis, this journal aims to stimulate wide public debate on issues concerning the interaction between science/technology and society. By exposing the problems, exploring solutions, and emphasizing the interdependence between research and the human condition, this 20-year-old quarterly provides a forum for ideas shaping human life in the future.

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From Tom Lucke, Chief, Water Resource Division, Ft. Collins, comes the note that the latest issue of *Land and Water Law Review* (Vol. XXI, No. 2, 1986) contains an article entitled "State Participation in Federal Policy Making for the Yellowstone Ecosystem: A Meaningful Solution or Business as Usual?" by Richard Schneebeck (pp. 397-416). Using Yellowstone NP and the grizzly bear issue as an example, the author delves into the question of whether individual states can play an effective role in protecting parks and their resources from adverse external development.

After analyzing Wyoming legislation, he concludes that current state legislation is an ineffective legal solution to the dangers facing the grizzly bear and Yellowstone NP. He goes on to state: "Finally, management of the grizzly bear and the Yellowstone region require a national response in which local participation is only one ingredient . . . Local participation is necessary in deciding how to protect grizzly bear. Local interests should not, however, dictate national policy, nor should they be used as a pretext to ignore the threats to the Yellowstone region."

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The same issue of *Land and Water Law Review* carries two articles on water rights in the Western United States: "Federal Reserved Water Rights in National Forest Wilderness Areas" by Nicholas Vassallo and "Wyoming's Experience with Non-Indian Reserved Rights: The Big Horn Adjudication" by Katherine Lamere. The latter gives a historical perspective on the adjudication of water rights at Yellowstone NP.

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The latest issue of *Environmental Law* (Vol. 16, No. 2, Winter 1986, pp. 207-254) contains an article entitled "Can Indians Hunt in National Parks? Determinable Indian Treaty Rights and United States v. Hicks" by H. Barry Holt. The recent arrest and conviction of two members of the Quinault Indian Tribe for killing elk within Olympic National Park raised questions about the nature and extent of Indian treaty rights and the Federal government's policy toward these treaty rights. This article analyzes determinable Indian treaty rights and the government's traditional construction of those rights. The author argues that

government interpretations are based on convenience, and are contrary to the canons of treaty construction and previous judicial decisions. Holt concludes that the Hicks defendants either have a treaty right to hunt in Olympic National Park or they deserve compensation for a taking of that property right.

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"The Acid Rain Whodunit," an article by Kenneth A. Rahn and Douglas H. Lowenthal, appears in the August 7, 1986 edition of *Natural History*. It describes a tracer system for air pollutants that has been in the development stage since about 1980 and was originally described two years ago in *Natural History* ("Who's Polluting the Arctic?" May 1984). The system has been adapted to the Northeast region of the United States. Applying the system to New England, the authors have found approximately 20 elements that are pollutants are particularly useful for tracing purposes. These include arsenic, antimony, selenium, zinc, indium, manganese, and vanadium. Significance of this approach lies in the fact that before it was applied, "the general assumption was that the pollutants had been generated solely in the Midwest. With the new knowledge that some local sources are *always* present, a good start can be made in controlling the original pollution."

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The editor's page of *American Laboratory* (May 1986) recounts a thought-worthy connection between an Austrian "accident" that occurred five years ago when an area of sick forest became heavily coated with gravel dust, and the publication in that same magazine in 1983 of a book review – *The Survival of Civilization* by John Hamaker and Don Weaver. The author had proposed in 1961 that the gradual depletion of available soil minerals by forests and other vegetation, following the retreat of glacial advances, triggers the cycle of events that initiate a new glacial advance. Their thesis is briefly outlined in the editor's page, as is the news that the gravel dust in Austria, instead of sealing the fate of the sick forest, rejuvenated it.

"Within a few months, all sick fir trees became healthy and subsequently all of the trees recovered completely from damage caused by acid rain. They grow 50 percent better than before; the beech trees lose their leaves four weeks later than usual. Grass, herbs, blackberries, and raspberries grow like never before, and the berries taste better than those from areas not exposed to the gravel dust. The deer population has grown and prefers the exuberantly growing grass," according to Fred Scott, Jr., *American Laboratory* editor.

Scott describes in some detail the Hamaker-Weaver thesis, and then writes:

"Despite extensive evidence supporting many aspects of the thesis, grant givers and recipients, both scientific and political, disdain to consider it. 'Acid rain' seems to conveniently explain forest decline and a bogus 'warming theory' seems sufficient to quell any serious examination of increasing atmospheric CO₂ while we proceed with the terminal rape of the planet."

Gerry Wright, wildlife biologist at the NPS/CPSU, University of Idaho, who sent in the item, asks: "Are we in natural resource management missing the big picture? This fellow certainly sees beyond his test tubes!"

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Barrier Island Hack Site Proves Successful in Gulf Islands Bald Eagle Restoration

By Ted Simons

Gulf Islands National Seashore is participating in a cooperative program to re-establish Bald Eagle populations in the Southeastern United States. The birds once ranged from Texas to the Carolinas, and bred as recently as the late 1940s on the Seashore's barrier islands in Mississippi. Unfortunately, eagle populations have declined in recent years to about 25 percent of their historic levels, owing to the combined effects of pesticides, habitat loss, and illegal poaching.

The restoration program is employing the ancient falconer's technique known as hacking in an attempt to re-establish a breeding population of Bald Eagles in the vicinity of the Seashore's Horn Island wilderness area, and at three other sites in the Southeast. The project is unique in its attempt to determine if egg removal from wild nests, captive rearing, and hacking, can be combined to restore populations of the endangered Southern Bald Eagle to their former levels. The effort is divided into three major phases, requiring the cooperation of a variety of state, federal, and private agencies.

In the first phase, eggs are removed from a healthy eagle population in Central Florida. Research over the last two years has demonstrated that if eggs are removed from eagle nests early in incubation, breeding eagles will "recycle" and lay a second clutch. In this way biologists can effectively double the productivity of the donor population in Florida.

Fifty-two eggs have been removed from 25 nests over the past two years. Twenty-one of the 25 donor pairs recycled, and their overall breeding success did not differ significantly from control pairs. All four recycling failures occurred at nests in which eggs were taken after the median date of egg laying. Thus it appears that the short-term impact of egg removal on the donor population will be minimal if eggs are removed early in the season. The long-term effect of

egg removal on the productivity and survival of donor birds and their offspring is not known. If the hacking program continues, this question will be examined as part of a concurrent long-term eagle population study in Florida.

In the second phase, the eggs are taken to the Sutton Center in Oklahoma, hatched in the laboratory, and hand reared for two months. Extreme precautions are taken during this phase to keep the birds from imprinting on their foster parents. In fact, the young eagles never see human during their two months at the Sutton Center.

The final phase of the project involves distribution of the birds to release sites in Georgia, Alabama, Oklahoma, and Gulf Islands. From the 52 eggs removed over the past two years, 41 nestlings have been distributed to the hack sites; this is a considerably higher rate of productivity than normally occurs in a wild population. The young eagles are placed on an artificial nest atop a 30-foot-high hack tower at the release sites, and allowed to fledge naturally at about 12 weeks of age.

Horn Island was chosen as a hack site this year because of its protected status as a National Seashore and a wilderness area, the historic evidence of nesting in the area, and the desire to evaluate the influence of an island hack site on the dispersal of young birds. In the wild, young eagles often spend a month or more with their parents after they fledge, gradually learning the skills they will require when they are on their own. Unfortunately, many of the birds hacked from mainland sites in other areas dispersed rapidly away from the hack sites, often leaving the area within several days of their release. It was hoped that the geography of Horn Island (12 miles long, 1/2 mile wide and 8 miles offshore) would encourage the young eagles to stay in the area and make a gradual transition to



A free-flying eagle returns to the hack tower to feed. A gradual transition to independence is essential to a successful hacking effort. All four eagles hacked in the park this year remained on Horn Island for over 2½ months after leaving the nest.

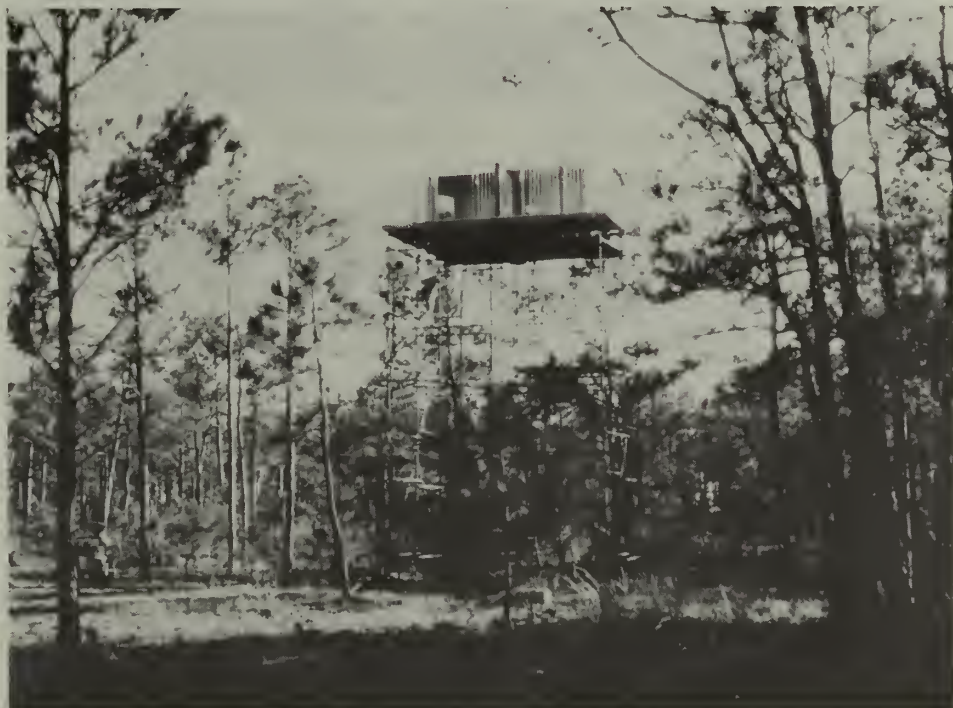
independence.

The hunch appears to have been correct. The four birds hacked this past winter were monitored with radio telemetry after their release, and all four remained on the island for over 10 weeks. The four birds departed (apparently as a group) on May 26th, presumably following their instinctive urge to migrate north for the summer. The skills and the social bonds developed during their long stay on the island should increase the likelihood that the birds will return to the area three to four years from now when they reach breeding age. The re-establishment of a breeding eagle population in the area is, of course, the ultimate objective of the program, but it is clear that an effort much larger than the present experimental project will be required if that goal is to be realized.

With that in mind, representatives from all of the hacking projects, the State of Florida, the Sutton Center, the U.S. Fish and Wildlife Service, and private and corporate sponsors met at the Seashore's William M. Colmer Visitor Center in mid-June to discuss the future of the program. Results of the two-year experimental phase of the project presented at the meeting indicated clearly that the methods will work. And, although funding is a major obstacle to continuance of the program, conference participants unanimously agreed that the effort should be expanded and continued for another five or six years.

Assuming the funding obstacles can be overcome, current plans call for hacking up to 100 birds a year in the Southeast for the next five years. In order to maximize the size of the breeding cohort returning to the release areas, a rotating schedule will be followed with each hack site participating in a mass release of 50-60 birds during one year of the five year program, and smaller releases during the remaining four years. If that goal can be accomplished, Southern Bald Eagle populations should be well on their way to recovery.

Simons is a Research Biologist at Gulf Islands National Seashore.



Horn Island hack tower. An observation room behind the nest cages was constructed so that volunteers could feed and observe the birds without being seen by the young eagles.

Alaska Region Gets Training Course in Placer Mining, Water Quality

By Juliette Wilson

When the Alaska National Interest Lands Conservation Act (PL 96-487) was passed in December 1980, millions of acres of federal land were designated national parks and monuments. At the time the act was passed, numerous placer and lode mining claims existed within and near what became national park area boundaries. Many of these claims were being worked until the National Park Service was sued in late 1985 for its alleged failure to properly regulate mining activities in Alaska. Placer mining, the recovery of gold from stream-bed materials, involves activities that seriously alter a stream channel as well as the quality of the water flowing through it. Regulations exist that are designed to protect that water quality, but enforcement to date has been neither consistent nor comprehensive.

In recognition of the need for a better understanding of the placer mining impacts that brought about the lawsuit, the effects of mining on water quality, and enforcement of the pertinent regulations, the NPS Alaska Regional Office staged a training course on the topic for park employees in the region. The course was held May 13-16 at the University of Alaska campus in Anchorage. Course participants included NPS resource managers and environmental specialists from the regional office and from national park areas in Alaska. Representatives from various state and other federal agencies connected with water quality and/or placer mining were also in attendance.

Wide Range Covered

The course covered a wide range of topics, including techniques for assessing water quality; the impacts of placer mining on water quality, aquatic life and aquatic habitat; legal considerations, standards, and criteria; strategies for developing water quality monitoring programs for streams affected by placer mining; water treatment technologies for placer mine operations; and reclamation of mined areas. Course attendees also participated in field and laboratory sessions designed to provide "hands-on" experience with monitoring equipment and techniques as well as some of the less complicated laboratory analyses. In addition to NPS specialists, course instructors included experts from Alaska state agencies and the University of Alaska who maintain close involvement with placer mining effects and regulations as a part of their regular work.

The training course ended with separate presentations by a mining industry representative and by an environmental activist, both of whom subsequently joined four other presenters in a panel discussion of placer mine operation and regulation.

Guest Experts Participate

The course was hosted by the NPS Alaska Region. The NPS Water Resources Division in Fort Collins, Colo. Bill Lawrence, Environmental Protection Specialist with ARO, served as course coordinator. Lawrence and hydrologists Mark Flora and Sam Kunkle (WRD) designed the course, and Juliette Wilson

(WRD/Colorado State University support staff) assisted in course coordination efforts. Other significant course planning efforts came from Bub Loiselle, Placer Mining Coordinator, U.S. Environmental Protection Agency (Seattle); Rick Inglis, Hydrologist, WRD; Barbara West, Environmental Protection Specialist, WRD; Nancy Deschu, Research Scientist, Denver Service Center; and Ross Kavanagh, Fisheries Biologist, ARO.

Wilson is on the support staff of the NPS Water Resources Division, Fort Collins, CO.



Mark Oswald of the Institute of Arctic Biology, University of Alaska, identifies stream-dwelling insects for trainees.



Trainees learn to use stream gauging equipment. Rick Inglis, NPS Water Resources Division, (2nd from right) instructs.



Bub Loiselle of the Environmental Protection Agency demonstrates proper collection of a "grab" sample.

Computer Corner

The TEX module is one of several data bases within COMMON, which is the "corporate data base" of the Service. With the recent installation of COMMON "on-line" Servicewide the TEX module also became available for use.

TEX will allow the exchange of selected information on federally listed Threatened and Endangered species and on eXotic species. It is not meant to serve as a primary data base for detailed park species information at the park level. A microcomputer software package will be designed to try to satisfy that need at a later date.

Individuals interested in a particular species will be able to use TEX to find out: (1) at what parks the species occurs, (2) the status of the species in each park, (3) what kinds of projects or activities are being carried out at parks, such as research, monitoring, captive breeding, reintroduction, habitat protection or, in the case of exotic pests, eradication or control programs, and (4) what publications relating to these species have been produced under the auspices of NPS. The individual can then contact a park or regional office for additional information on activities or publications of special interest.

WASO has responsibility for entering data on taxonomy and data element definitions. The other data must be entered and updated by the parks themselves and/or by the regional offices. Security is such that parks can enter only their own data. Regional offices can enter data for any of their own parks. WASO can enter any of the files, if necessary.

However, everyone has the capability of reading, or viewing, any of the information in the data base at any time. As with other modules of COMMON, TEX species information is available through standard (preprogrammed) or customized (individualized) reports. Presently there are four preprogrammed reports available in TEX. These can be used to derive information on the various TEX species topics mentioned earlier. Where applicable, these reports offer the user the option of having the information presented on a single park, for a region or Servicewide.

For variations on these standard TEX species reports, or for different kinds of readouts entirely, customized reports can be developed by the use of RELATE/3000, the data base management software package of COMMON. Customized reports also allow a link-up between TEX and other modules of COMMON, including one on park pest management (PESTS) and another on park flora (NPFLOA). With these links different kinds of data can be brought together in a variety of ways to answer a wide range of questions relating to park issues. To do this the user will have to become familiar with some of the basic commands of the RELATE language. This aspect of data retrieval is discussed in the user's manual for COMMON, which is now available Servicewide.

As with other portions of COMMON, the completeness of the TEX data base is dependent upon the willingness of parks and regional offices to enter data describing their park into the system. It is our hope that the parks and regional offices will find this basic

mab notes

Selection panels are being formed to recommend new Biosphere Reserves for two regions of North America. A panel dealing with the Acadian Boreal Coastal Region, which extends from Cape Cod to the Strait of Belle Isle between Labrador and Newfoundland, will have its first meeting in early November, pending confirmation that representatives of MAB Canada can join the session. The California Biogeographical Province, which includes chaparral and grassland communities, will come under scrutiny at a panel meeting to be held in November at Los Angeles in conjunction with an international symposium on chaparral ecosystems.

* * *

Bill Gregg, NPS MAB Coordinator, and two other U.S. representatives attended the second meeting of the MAB Science Advisory Panel for Biosphere Reserves in La Paz, Bolivia, Aug. 18-24. Major agenda items included review of a draft "operational guidelines" for Biosphere Reserves; recommendations to the MAB Bureau on new areas nominated to become Biosphere Reserves; discussion of a paper on "model" Biosphere Reserves around the world; and assessment of results of a detailed questionnaire sent to all Biosphere Reserves to collect information on their status and activities. In connection with the latter, Bill expresses deep appreciation to the managers of U.S. Biosphere Reserves for their response; as of Aug. 10, 39 of 43 had replied.

* * *

A MAB symposium on temperate forest ecosystem

management, held July 5-11 at Changbai Mountain Research Station in northeastern China, may have opened up interesting new avenues for U.S.-Chinese scientific collaboration, including projects linking Biosphere Reserves in the two countries. Peter White, former director of the NPS/CPSU at the University of Tennessee who was one of three American participants, reports that the Chinese are particularly interested in future cooperative research on similar ecosystems in the U.S. and China, methods of long-term vegetation research and monitoring, and conservation management. He suggests that Changbai and Great Smoky Mountains Biosphere Reserves might be paired in conducting comparative research on temperate deciduous and spruce-fir forests.

* * *

A Southern Appalachian connection may also be developing with West Germany. A letter from the chairman of the West German MAB Committee endorses cooperation with the Southern Appalachian BR on prototype studies of integrated small watershed ecology. This would involve primarily Oak Ridge National Laboratory, but possibly also Great Smokies.

* * *

The MAB inventory of U.S. reserves 5000 acres or larger is launching its pilot test in Florida. A questionnaire is being sent to all such public and private reserves in the state to obtain data on management objectives. The information will be used to determine levels of protection provided to natural ecosystems.

* * *

Development of a process for collecting and managing species data for Biosphere Reserves and other biologically rich areas is the purpose of the Smithsonian/MAB Biological Diversity Program, directed by entomologist Terry Erwin. The first step in this program – development of protocols for biological survey data management, collection and storage of voucher specimens, and training, primarily of Third World biologists, on how to do the first two – will be assisted by Francisco Gomez of Venezuela, recently hired as a research associate at the Smithsonian for this purpose. The program will then conduct surveys of Biosphere Reserves and other species-rich areas, recording all flora and fauna including less-collected groups such as invertebrates and lichens. Population changes over time will be measured on permanent plots established in Biosphere Reserves. Among other benefits, the program should give a major boost to our knowledge of the immense tropical biota. Bill Gregg would appreciate receiving information on existing species data base systems in Biosphere Reserves that might be useful to this MAB program.

TEX species information useful and that all units will cooperate in providing current data on their species for Servicewide exchange.

The first demonstration of COMMON, including the TEX module, was given in May at the Mid-Atlantic Regional Office in Philadelphia. It was followed by one in June at the Southeast Regional Office in Atlanta. Similar demonstration workshops are planned for each Region during the summer. For further information you may contact Nick Chura, WASO Science Support Staff (FTS 343-8123 or (202) 343-8123); or Trish Patterson, SERO Resources Management Specialist (FTS 242-4916 or (404) 331-4916). For more information on COMMON in general, or on the scheduled COMMON workshop for your Region, contact Keith Carr, WASO Information and Data Systems Division (FTS 343-4463 or (202) 343-4463) or your Regional ADP Coordinator.

Nick Chura, WASO Science Support Staff.

See also North Atlantic Regional Highlights for Computer News.

Napier Shelton
NPS Washington Office

Oregon Caves Restoration Underway

By Jonathan B. Jarvis

Oregon Caves, the principal resource of Oregon Caves National Monument (ORCA), are a series of limestone caverns located at 4800 feet in the Siskiyou Mountain of Southern Oregon. A perennial stream flows through the cavern floor and the features are primarily composed of marble, unusual for the Northwest. Receiving approximately 200,000 visitors a year, the cavern is a significant unit of the National Park System.

Management actions born of ignorance, coupled with benign neglect, can have significant impacts on a park resource. It may not always be so clearly illustrated as it has been at Oregon Caves. To create a "showcase," easily accessible to the public, with illuminated features, early administrators took actions that have had far reaching impacts on the cave. Those actions were:

- Altering the natural cave openings, enlarging some, closing others.
- Constructing connecting tunnels between natural passageways.
- Constructing a 400-foot exit tunnel blasted into the rock.
- Installing an asphalt trail the length of the tour route.
- Hiding all material generated by trail and tunnel construction in alcoves, side tunnels, and on natural shelves within the cave.
- Installing a lighting system of numerous three-foot fluorescent lights.
- Diverting the cave stream into culverts.
- Allowing and even encouraging the handling and removal of cave features, such as speleothems, by visitors.

The results, subtle at times, are now better understood. Alteration of the cave entrances had affected the natural airflow, an important factor in continued speleothem growth. Addition of the connecting and exit tunnels created a chimney effect that dries the cave in summer and cools it in winter. Cool moist air pools in the cave, freezing the wet features, leaving extensive frost cracking and "delamination" of flowstone. The material left behind during cave trail construction obscures features and creates a claustrophobic atmosphere. Material left in contact with wet features for many years had become "glued" in the cave formation process, thereby destroying the features' integrity. The intensive fluorescent lighting, along with the moisture, has created greenhouse conditions for luxuriant growth of mosses, algae and ferns. Exotic plant growth in turn damages the features and presents an unnatural appearance.

Diversion and culverts have buried the stream deep below the trail, removing an important visitor experience. The asphalt of the trail has been breaking up for years and pieces of black asphalt now line the visible section of the cave stream. Handling of cave features has discolored them with body oils. Vandalism of speleothems needs no further explanation.

In 1985, with plans to revamp the cave lighting

system, a full scale cave restoration was undertaken. A cave management consultant from Ozark Underground Laboratories was brought to ORCA to recommend restoration and management procedures. Other cave specialists were consulted and the restoration process began. (See *Park Science* Winter 1986, p. 9, "Green Sickness Prevention" by Tom Aley)

Exotic Plants: The first step was to treat the exotic plant growth with a 5.25% sodium hypochlorite (undiluted standard household bleach). The solution was applied by hand sprayers directly to the vegetation. The dead vegetation was then removed by hand. Retreatment was used where necessary.

Cave Rubble Removal: A 10-person crew began removing past construction rubble. Because the cave trail is narrow and broken by several sets of stairs, the material had to be hauled by a relay system using five-gallon buckets and then by toy wagons. Material was stockpiled outside the cave entrance and later hauled out of the Monument. During the winter of 1985-86, 270 cubic yards of rubble were removed from the main entrance to the 110-foot entrance. Extreme care was used to separate rubble from undamaged features.

Cave Washing: Once the bulk of the rubble was removed from an area, a thin film of soil usually remained on the previously buried features, creating a dull brown color rather than the white of limestone. Features were washed with a light mist of water, with pressures kept to a minimum to prevent speleothem damage. Mud was collected in small check dams along the cave trail. Volume also was kept to a minimum to prevent impact to the River Styx which flows through the cave. Downstream impacts in Cave Creek were monitored by observing the large stocked rainbow trout located in visitor viewing pools just outside of the cave entrance.

Airflow: A study was conducted of the unnatural airflow through the cave. Temporary air locks were installed and measurements taken at various locations. Radon gas measurements also were taken relative to the air movements.

All of the above operations took place during normal visitor use. Rather than a hindrance to visitors, the restoration was used as an opportunity for interpretation. Visitors seemed wholeheartedly supportive of the operation and its very visible results.

In May 1986, a task force at ORCA reviewed actions taken so far and recommendations for future renovation. Members recommended that the restoration program continue in phases, with the eventual goal of removing all cave rubble and restoring the natural stream course. Cyclic treatment of exotic plant growth will continue and air locks will be installed to restore the natural airflow. All projects planned will incorporate the visitor use operation as well as seasonal use of the cave by local bat populations. Much of the program's success is due to the expert guidance provided by Tom Aley, director of the Ozark Underground Laboratory at Protem, MO, and Cave Geologist Ron Kirbo from Carlsbad Caverns NP.

Results have been impressive. Features previously obscured now are visible, alcoves are reopened, and discolored features have been returned to a more natural appearance. From the main entrance to the 110-foot exit, the removal of 270 cubic yards of material has created a less confined tour route. Control of unnatural air flows has prevented ice damage to the features and restored the cave's climatic equilibrium.

Much work remains; an estimated 500 cubic yards of rubble are still in the cave. Once the rubble is

Water Resources Division

A new report on *Giardia* research conducted in 1985 is available from the WRD. Entitled **Giardia Contamination of Surface Waters: A Survey of Three Selected Backcountry Streams in Rocky Mountain National Park** (Water Resources Report No. 86-2), the report presents the results of stream-water sampling in three high-elevation, low human-use basins in the park. This study was a follow-up to one conducted in 1984 in two of the park's most popular hiking areas. The 1984 study results are described in Report No. 85-3 of the Natural Resources Report Series, **Field Survey of Giardia in Streams and Wildlife of the Glacier Gorge and Loch Vale Basins, Rocky Mountain National Park**, released last year.

Two additional reports also are newly available. **The Response of Experimental Channels in Everglades National Park to Increased Nitrogen and Phosphorous Loading: Data Report**, Water Resources Report No. 86-6, describes the data management scheme and presents the major data files created for an 18-month study of nutrient addition into the Shark River Slough. This report includes water quality and primary productivity information. **Water Quality Monitoring Alternatives for the Glen Canyon NRA Water Resources Management Plan**, Water Resources Report No. 86-3, describes water quality monitoring strategies that address water resource issues in GLCA.

All reports are available from Juliette Wilson, National Park Service, Water Resources Division, Federal Bldg., Rm 343, 301 S. Howes St., Fort Collins, Colorado 80523.

removed, a new trail and new lighting system will be sensitively installed to protect and highlight the cave features. This continuing project stands as an example of how a scientifically applied resource management program can restore a significantly altered cave environment to a "near natural" condition.

Jarvis is Resource Management Specialist at Crater Lake National Park in Oregon.

Regulated Lake Levels and Voyageurs National Park

Editor's Note: The following article, derived from a comprehensive Water Resources Report (WR 86-5), available from the NPS Water Resources Division in Fort Collins, CO, is presented here to show managers and resources staff the merits and application of hydraulic/hydrologic modeling.

By Marshall Flug

Voyageurs National Park, located along the Minnesota-Canadian border, is a complex network of lakes, rivers, portages, and dams that occupy glacier-carved rock basins and extend into bogs, marshes, and beaver ponds. The international boundary, between the United States and Canada, follows the 18th century fur traders route between Lake Superior and Lake of the Woods; Voyageurs NP adjoins a 56-mile stretch of that Voyageurs Highway. Figure 1 provides a flow chart of the hydraulic system with a brief hydrologic description of four major sub-basins given in Table 1. The relative sizes and active depths of Namakan and Rainy Lakes are such that a one-foot change on Rainy Lake is equivalent to a volume of water for a three-foot change on Namakan Lake. These two lakes contribute about two-thirds of the total inflow and represent more than one-half of the drainage area into the much larger Lake of the Woods.

Although both Namakan and Rainy Lakes existed as natural water bodies, today the reservoirs are larger and regulated to satisfy many specific concerns. Around the lake shores, groups primarily concerned with lake levels include resort owners, tourist outfitters, wild rice harvesters (including native people), pulp and paper companies, municipal water suppliers, commercial and sport fishermen, and commercial and recreation navigators. However, apparent conflicts exist because some interests prefer higher lake levels when others desire lower lake levels, particularly during the spring and summer months. Additional concerns include navigation and pollution abatement, which are dependent on reservoir outflows.

The National Park Service is most interested in restoring "natural conditions" (to comply with the Organic Act) whereas regulated conditions differ in both magnitude and timing from historic natural lake level fluctuations. These physical differences result in alterations of the shoreline habitat and littoral zone, directly affecting the abundance and distribution of the fish, birds, mammals, plants, and invertebrates that use these habitats. Additionally, construction of a dam and powerhouse on the Rainy River paved the way for development of forest product mills, which in turn created communities at International Falls, Minnesota and Fort Frances, Ontario; a transition from fur-trading posts to small urban communities.

Historical Lake Levels and Regulation

Artificially regulated levels have existed on Rainy Lake since completion of the International Falls Hy-

Subbasins	Active Depth ft	Lake Area mi ²	Drainage Basin Area mi ²
Namakan Lake	11	100	7440
Rainy Lake	4	345	7460
Rainy River			6570
Lake of the Woods	6	1485	5700

droelectric Project at International Falls/Fort Frances in 1909 and on Namakan Lake since completion of Kettle Falls and its sister Canadian dams in 1914. The lower lines of Figures 2 and 3 represent the computed natural long-term mean lake levels, respectively, for Namakan and Rainy Lakes (i.e., assuming no dams existed). Of course, there is considerable variability, from year to year and month to month, about these long-term average lines, with variations amounting to as much as seven feet. The point is that naturally occurring lake levels and discharges (i.e., river flows) are variable with time in an uncontrolled system as compared to a highly regulated system. This difference has strong implications for the conservation of scenery, natural objects, and wildlife and preservation in an unimpaired state for future generations.

In 1909 the Boundary Waters Treaty between the United States and Canada was created and established the International Joint Commission (IJC), which is responsible for overseeing reservoir water levels and flow releases. The IJC appoints International Boards of Control, which study and then recommend specific water levels and discharges at different parts of the year. Such defined values constitute "rule

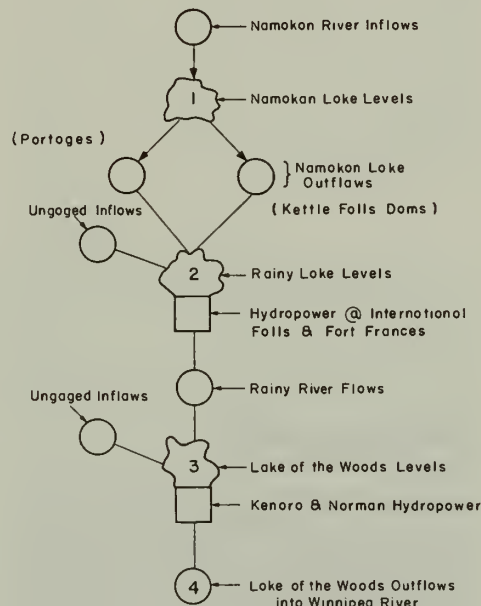


Figure 1. Flow Chart of Water Flows through the Three Reservoir System of Voyageurs National Park

curves" for reservoir operation for securing the most advantageous use of waters. The initial IJC Order of 1949 established specific criteria for flow releases and surface water levels at both Namakan and Rainy Lakes on a monthly basis, with major Amendments added in 1957 and 1970.

The 1970 rule curves (rule band) are shown in Figures 2 and 3, respectively, for Namakan and Rainy Lakes. The maximum lake level rule curve is

(Continued on page 22)

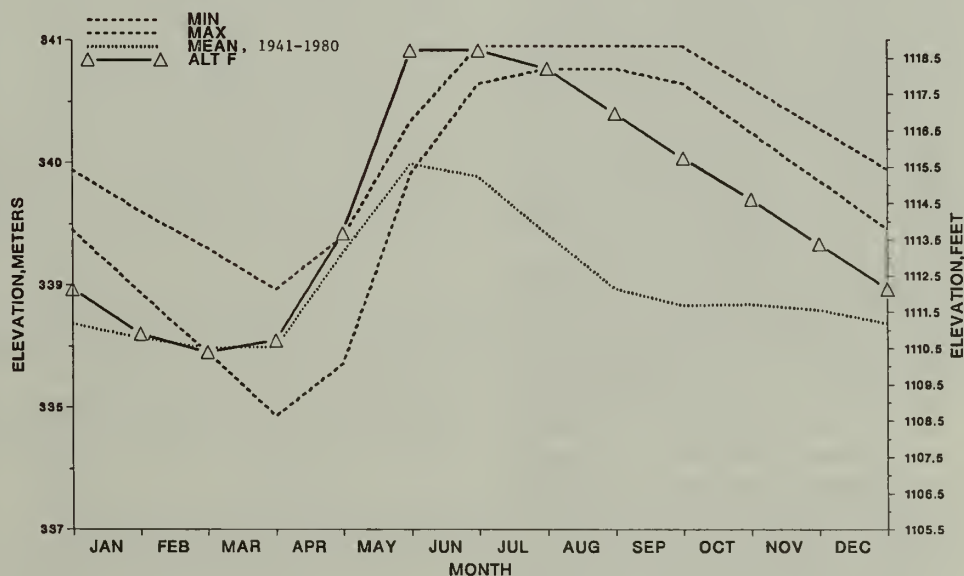


Figure 2. Namakan Lake Levels

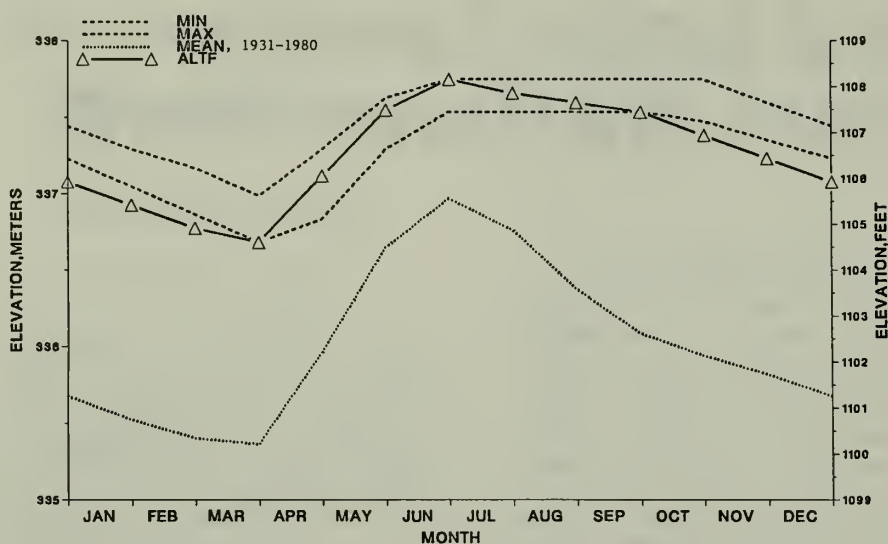


Figure 3. Rainy Lake Levels

Voyageurs NP

Continued from page 21

identified by the MAX curve on Figures 2 and 3; the minimum levels of the IJC order correspond to the curves labeled MIN. In brief, the 1957 and 1970 Amendments modified the timing at which full reservoir levels were achieved, adjusted the low level in April to improve fish spawning, replaced the rule curve with a maximum and minimum rule band, redefined "emergency conditions," provided greater flood reserve capacity, and established minimum discharges for downstream pollution abatement.

Model Description

The NPS became interested in evaluating alternative rules for reservoir operation to complement their involvement in studies of littoral biota, vegetation and benthic organisms, fish communities of walleye and northern pike, shore and marsh nesting birds, beaver, and muskrat. These biologic studies are directed at answering questions related to management policies and their effect on preservation of the natural environment. A mathematical simulation model of the multi-lake watershed is a valuable tool to permit management to evaluate whether slight modification of the regulated operation rules can reduce adverse effects on Park aquatic and riparian life without conflicting with other authorized uses of water.

A conceptual schematic, which identifies the major components of the modeling approach, is given in Figure 4. In brief, the hydrologic/hydraulic system of concern is isolated and the flow path of water through the rivers and lakes identified.

Figure 1 portrays the hydrologic/hydraulic system of the drainage basin in a flow chart format. The network system begins at the upstream end of the watershed with inflows to the Namakan Lake chain and proceeds through the lake with outflows via Kettle Falls Dams and portages. These outflows then enter Rainy Lake along with other unmeasured inflows. Flows out of Rainy Lake are all through the dam at International Falls/Fort Frances and generate hydropower up to a maximum turbine discharge and based on a turbine efficiency. These Rainy River flows then become input to Lake of the Woods along with other ungaged inflows. Discharges from Lake of the Woods are through the hydropower facilities at Norman and Kenora.

The drainage basin network shown in Figure 1 is interpreted as a series of *nodes* and *links* that operate by defined mathematical relationships. A mass balance model simulates the lake system by maintaining continuity between reservoirs in the system such that:

$$\text{Inflow} = \text{Outflows} + \text{Change in Storage}$$

where, Inflows serve as the input data (i.e. the independent variable); Outflows are computed at each node (i.e., dam outlet); and the Change in Storage is computed for each reservoir.

In addition to continuity, various constraints are included in the model, representing physical or legal limitations of the reservoir system. These constraints include maximum outflows through existing outlet works, minimum flow requirements for water pollution, both maximum and minimum lake levels, and others as appropriate. The resulting mathematical equations are then solved for the input data given (i.e., hydrologic inflows).

Operating Rules

The "operating rules" provide attributes by which

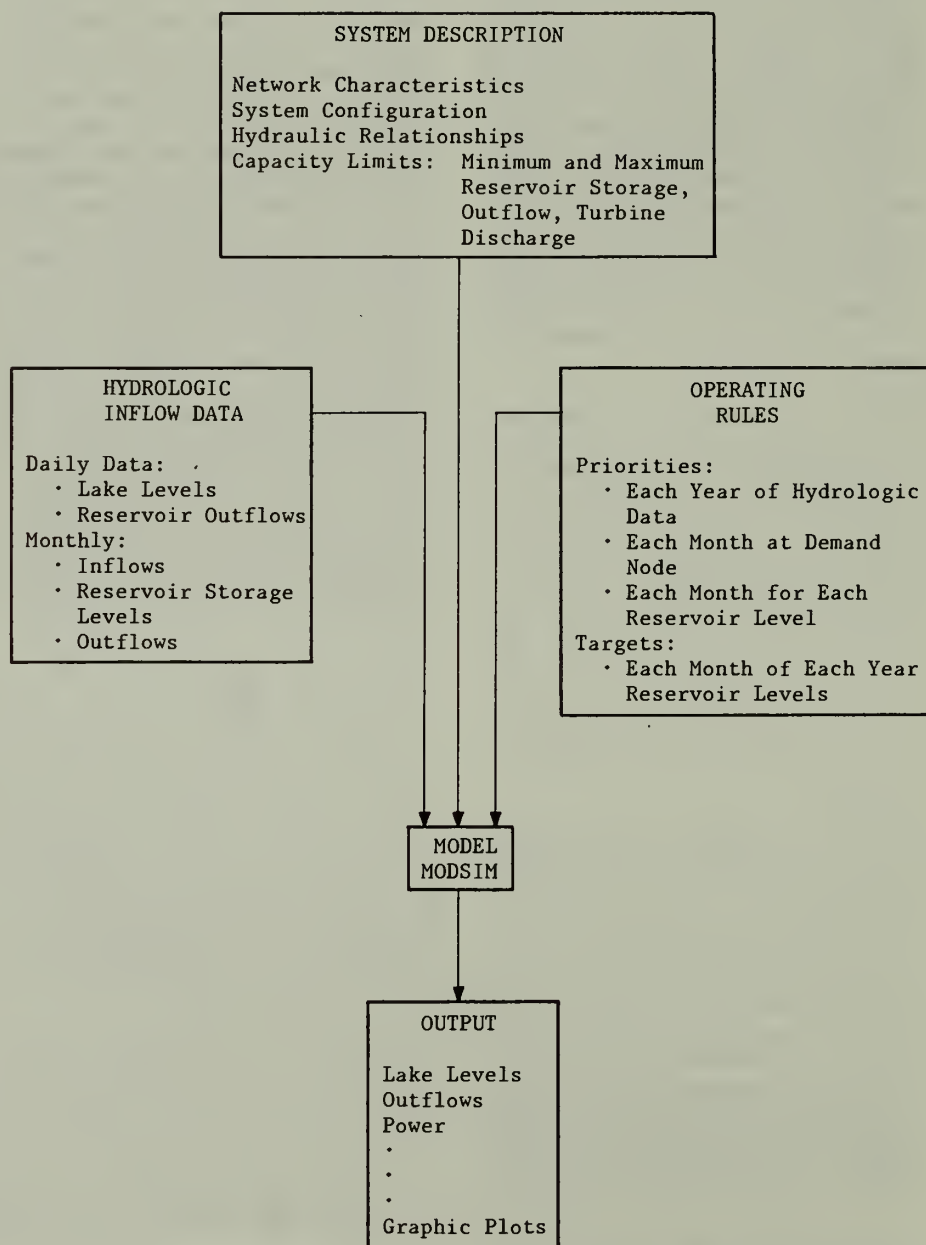


Figure 4. Model Overview

the model is instructed to allocate and route water through the system. To simulate management options for reservoir operation requires a set of alternative operating rules for Namakan and Rainy Lakes. The target lake levels, labeled ALT F in Figures 2 and 3 are only one example of an alternative set of operating rules. Specific values associated with ALT F in Figures 2 and 3 for each month are selected by attempting to follow the pattern and aspects of the naturally occurring lake levels. The natural levels are shown as the mean in these figures. Adjustments were made to these naturally occurring flows to accommodate the higher lake levels created by the dams at Kettle Falls and at International Falls/Fort Frances.

After simulating the operation of this system for the hydrologic input data and subject to the hydraulic constraints, the resulting lake levels, reservoir outflows, and hydropower generated each month of the simulation are output. Specific management options are analyzed by comparing the results from simulations (with alternative target operating rules) to historic reservoir regulation rules. Numerous graphic and tabular options are used to compare results from one simulation to another.

Summary

Aquatic and riparian habitats within Voyageurs NP are influenced by dams constructed in the early 1900s, regulated for the primary purpose of hydropower generation. Reservoir operating rules, which primarily specify desired lake elevations but also define limited discharge constraints, evolved over the years. Changes were periodically implemented in response to various lake shore interests and due to difficulties in operating the physical system in adherence to the existing rules of regulation. Interest groups continue to voice their concerns for more natural lake level fluctuations, different timing of peak and low lake elevations, increased flood storage reserve, navigation, and improved water levels for fish, wild rice, nesting birds, and other aquatic and riparian life, as well as individuals and resort owners with vested lake shore interests.

Of late, the NPS (circa 1975) was given the responsibility to conserve natural objects and wildlife, and to leave them unimpaired for future generations. This is a formidable task for a system that was regulated for over half a century.

The Park Service is interested in management options for regulating lake levels and reservoir outflows to accommodate all beneficial uses of these waters. An optimizing simulation model is used to help assess the impact of alternate reservoir operating rules on various lake shore interests. An analysis of impacts on specific beneficial uses of these waters is quantifiable by simulation modeling. Such an effort supplies sound information for evaluating management options.

As new data become available, from ongoing aquatic and riparian studies, alternative reservoir target elevations can be modeled. The results provide information for discussions and negotiations between Federal, State, international, and private interests, and can lead to mutually agreeable solutions for continued beneficial use of these waters. Use of a simulation model and the associated output provides concrete indications as to what changes are possible and goes a step beyond idle rhetoric of what are and are not realistic management options.

Flug is a Hydrologist with the NPS Water Resources Division, Fort Collins, CO 80523.

Feral Horses: Grazing Impacts, Genetics and Birth Control

By Dr. Susan Bratton

One of the most complex problems for southeastern National Seashores, and one of the most visible to the public is the management of feral horse or pony herds. Three southeastern parks have "wild" horses and all three have different concerns. Cape Hatteras National Seashore keeps a small number of "Banker" ponies, descendants of original Outer Banks stock, in an enclosure on Ocracoke Island. This management strategy eliminates grazing impacts outside the "pony pen," but limits the number of animals the park can maintain without supporting the herd completely on imported hay. The Hatteras ponies may already be inbred and could eventually cease to reproduce. The park plans to keep a few animals for visitors to observe, but does not wish to reestablish free-ranging herds, nor do they wish to replace the Banker ponies with some other genetic stock. The question is how to manage a small but genetically viable herd.

On Shackleford Bank, Cape Lookout National Seashore, free-roaming horses have long joined other ungulates, including cattle and goats, in grazing marsh and interdune vegetation. Domestic livestock have certainly been present on the Outer Banks at least since the 1600s, and the horses are supposedly of Spanish origin. Over-grazing was reported in the early 1800s on nearby Portsmouth Island and goats and other species may have helped remove maritime live oak forests from the islands. Cape Lookout NS plans to maintain the Shackleford horses as an "historic resource," but is concerned the populations may increase after other feral animals are removed. The question is: Will the Shackleford horse population remain stable and are their present impacts on park vegetation acceptable?

Cumberland Island NS also has free-ranging horses, probably relicts of fairly recent introductions. Both Spanish and English colonists and soldiers brought horses to Cumberland before the Revolutionary War, but it is highly unlikely the Cumberland horses are descendants of Spanish stock. The island was under intensive cultivation during the plantation era, making large herds of feral animals unwelcome. Livestock roamed free on the Sea Islands after the Civil War, but families returning to the devastated farms after the conflict rounded up the more valuable animals. Although some of the Cumberland horses may be descendants of "marsh tackies," most are the progeny of horses introduced by the Carnegies in the late 19th Century or brought over in more recent times to improve island blood lines. Appaloosas on the north end of the island may be descendants of one stallion introduced to the island within the memory of local residents.

Cumberland Island already has serious problems with overgrazing. Park staff have greatly reduced feral hog numbers by live trapping but native white-tailed deer are heavily browsing forest understories. Both horses and deer preferentially graze interdune grasslands. Horses wade out into high salt marsh and consume large volumes of *Spartina* and other marsh plants.

The present General Management Plan for Cumberland calls for maintenance of a representative horse herd. The horses can be considered "historic," but the primary motive for keeping them is their popularity with visitors. The questions for Cumberland are: How many horses can the island sustain without ex-

tensive resource damage and where should the herds be allowed to travel over the island?

Present research efforts centered at the NPS/CPSU at the University of Georgia are attempting to integrate assessment of equine impacts on native ecosystems with behavioral data, population monitoring and genetic profiles of the herds. Park managers should eventually determine optimal population sizes not just in terms of forage availability and ecosystem carrying capacity, but also in terms of inbreeding coefficients.

Evaluating Impacts

Horses are of course not native to the barrier island ecosystem and may have damaging impacts. A study by Monica Turner, for example, has shown large reductions (as much as 98%) in above and below ground productivity in Cumberland Island saltmarshes that can be attributed to grazing and trampling by horses. The reduction in vegetation may also affect the food web and sediment deposition both in marsh and dune areas.

Georgia researchers have erected tandem deer-horse exclosures in oak forest and inter-dune grassland on Cumberland Island. One side of an exclosure is closed to deer, horses and hogs, the other side can be entered by deer and hogs but not by horses. These exclosures will help to discriminate grazing impacts of deer from those of horses.

Kathryn Davison has completed a productivity study of the Ocracoke Pony Pen, which indicated the area could support the present herd during the summer, but winter forage was very limited. Productivity of the pen could only be improved by intensive management, including repeated fertilization. The park thus can only increase herd size with substantial financial inputs for pasture management and hay. Increasing the size of the pony pen is a poor alternative because exotic herbs and grasses presently dominate the enclosure and could spread into new grazing areas.

Populations and Behavior

All the parks have accurate population census data. Cumberland's population appears to still be increasing and the age structure may be changing, with the number of foals and yearlings proportionately. Chief Ranger Kevin Kacer and interpreter Marlene Finley not only improved the 1985 census by adding an aerial survey that could locate horses in marshes remote from the shoreline, but also began to monitor foal mortality. The 1985 Cumberland census counted about 180 horses, an increase of 25% over 1981. Dan Rubenstein of Princeton University has several years of data on family group structure of Shackleford horses. Mark Lenarz of the University of Georgia has completed a study of stallion territories on Cumberland, indicating an average of two mature mares per stallion with harems and the presence of bachelor herds of stallions without harems.

Genetics

A critical item for managing a small number of large vertebrates is a genetic profile of the population. Robert Warren and Robin Goodlow, a graduate student from the University of Georgia, are planning to obtain blood and muscle tissue samples from all three

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island horse herds. Using electrophoresis they can determine how inbred the herds are. Mike Smith of Savannah River Ecology Laboratory, a collaborator on the project, suspects the Shackleford herd already has passed through "a genetic bottleneck" and is viable in the long-run. This may not be true for Cumberland's horses and the Ocracoke population may simply be too small. Genetic study may also allow researchers to determine if any of the island populations are closely related to one another and can assist in a search for suitable studs for outbreeding local groups, such as the Ocracoke herd.

This research also has implications for management of small, isolated populations of endangered vertebrates that may collapse when the gene pool becomes too limited.

Computer Models

Cape Lookout NS has taken the lead in requesting a computer model that will allow managers to predict the effects of different-sized horse populations on Shackleford Bank. Lee Graham of the University of Georgia is developing a model for an IBM-PC micro-computer that allows a manager to select the vegetation productivity deemed acceptable. The model then

suggests a removal strategy if there are too many horses in the population. The model not only considers vegetation health, but also attempts to minimize inbreeding coefficients for the horses. The model imitates horse movement from marsh to dune communities and attempts to reproduce actual conditions on Shackleford Bank by using vegetation maps prepared by North Carolina State University. Monica Turner has developed a grazing model for Cumberland horses. The model predicts that a population of 60-75 horses will allow the marshes to maintain productivity without a great decline in vegetative cover. Although models are only an imitation of ecological reality, they can serve as important guides for managerial decision-making, and can warn managers of potential errors or undesirable management strategies.

Birth Control

A final element in the research concerns reducing or stabilizing horse populations. Dr. Robert Warren and Goodlow began in Spring 1986, to test the effects of birth control techniques on Cumberland horses. The first experimental method was vasectomization of stallions through injection of a chelating agent into the vas deferens, rather than through surgery. If a suitable

chemical can be obtained, this will be followed by application of long-term hormonal control, agents to mares, probably by implantation. Monitoring following treatment will not only assess inhibition of foaling, but will also evaluate other effects, such as behavioral changes and modifications of harem structure.

Although all three southeastern National Seashores with feral equines should ultimately have individually tailored horse management plans, all three will move to reduce undesirable impacts while maintaining viable populations. The strategies will be based on carefully collected vegetation data, studies of natural behavioral patterns, genetic analysis, and long-term data on population change. With the use of computer models, managers should be able to respond to catastrophic events, such as storm mortality, and should be able to adopt action plans to long-term population fluctuations. The implementation of hormonal birth control for mares is potentially reversible, allowing an animal to reenter the breeding pool if necessary. The ultimate management program should preserve highly visible historic resources, while protecting fragile biological systems.

Dr. Bratton is Coordinator for the NPS Cooperative Park Studies Unit at the Institute of Ecology, University of Georgia at Athens.



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ISSN-0735-9462